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OCTOBER

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

SEP 30 1932

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Mottled Enamel—*McKay*
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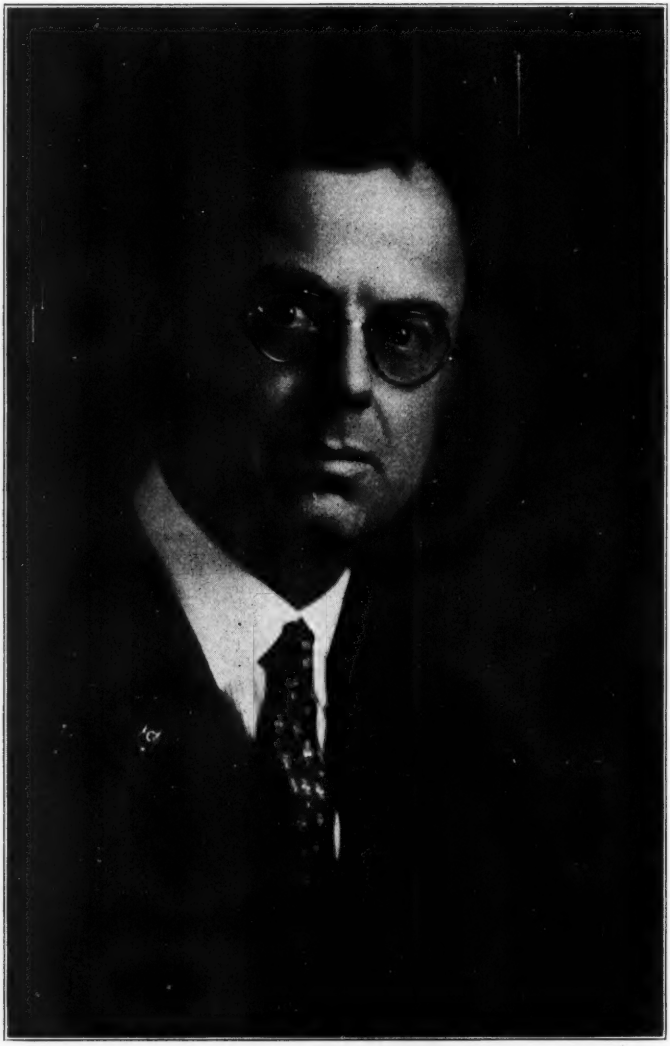
The Journal of the American Dental Association, Vol. XIX, No. 10. Published by the American Dental Association, 212 East Superior Street, Chicago, Ill. Yearly subscription, $2.50. Entered as second-class matter, May 1, 1928, at the postoffice at Chicago, Ill., under the act of Aug. 24, 1912. Published monthly.



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President Elect of the American Dental Association

THE JOURNAL
of the AMERICAN DENTAL ASSOCIATION

Vol. 19 OCTOBER, 1932 No. 10

Original Communications

EFFECTS OF VARIATIONS IN MANIPULATION ON DIMENSIONAL CHANGES, CRUSHING STRENGTH AND FLOW OF AMALGAMS*

By MARCUS L. WARD, D.D.Sc., and
ERMAN O. SCOTT, M.S., Ann Arbor, Mich.

SOON after the American Dental Association adopted the tentative specifications proposed by the United States Bureau of Standards, in October, 1929, and it seemed probable that there would be a standardizing agency working toward improvements, we added an interferometer to our dimensional change equipment. For several years, we had had an optical micrometer (Fig. 1), but the preference of the Bureau of Standards for the interferometer made us anxious to compare the practicability and accuracy of the two instruments. In addition, we had found one instrument insufficient for demonstration purposes in the course in metallurgy.

After the purchase of the interferometer, we adjusted our two instruments so that they would accommodate the 1 cm. specimen which had been proposed in tentative specification No. 356, and proceeded to compare the instruments and to compare the results that we obtained with those obtained by the Bureau of Standards, as published in THE JOURNAL. This was a new experience, as we had previously had only one instrument. With the use of the one instrument, which compelled us to make a test on one day and then wait until the next day before making another, we had become accustomed to variations in results, which we attributed to variations in technic that were supposedly uncontrollable. With the two instruments, we supposed that we could make two tests closely enough together that, when making the second, we could remember what was done in making the first. This proved to be untrue, for we would frequently find that the two instruments would not check.

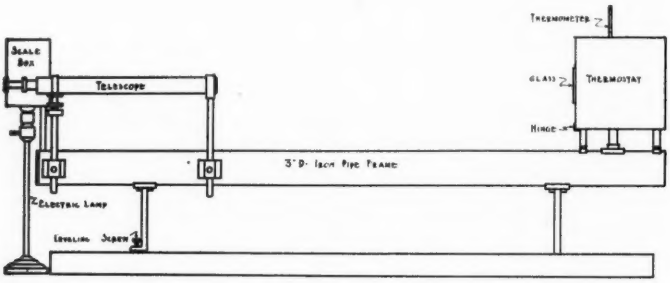
For a time, this proved to be very annoying. The feeling that we could not, under the most favorable conditions

*Preliminary reports were printed in the Journal of Dental Research (11:481 [June] 1931; 12:561 [June] 1932).

in a laboratory, make test specimens uniformly alike within the limitations of Federal specification No. 356, which had been adopted, caused us to ask, "Is it strange, then, for a practitioner to have a few bad results, considering the conditions under which he works?"

that there must be some things about the technic of making amalgam fillings which had never been discovered or else we were not observing them.

Our next step was to purchase two more interferometers and set them, with the one we already had, under one view-



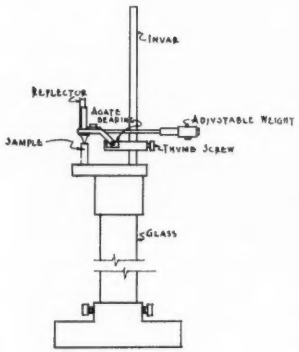


Fig. 1.—Optical micrometer.

During the early part of these experiences, we thought that we would perhaps have to eliminate some of the results which seemed to be most abnormal when we arrived at conclusions. As we studied the matter further, we decided

ing apparatus (Fig. 2) so that, with the optical micrometer, we could test four specimens simultaneously. With four specimens under observation at one time, and all made as nearly alike as we could make them, we had hoped to discover

the reasons for our inability to get our instruments to check. The four instruments only amplified the irregularities.

Our next step was to try to check the instruments against the ones at the Bureau of Standards. As soon as arrangements had been made to do this, five samples were sent from the Bureau to be analyzed, and to be tested for dimensional changes, crushing strength and flow. When we finished these tests and analyses, and reported to the Bureau, it was found that the analyses, flow tests and crushing tests checked very well, but we checked with the Bureau on only three of the five tests made for dimensional changes.

While we were repeating the work on the two samples which did not check, a meeting of a dental society was attended at which several dentists were asked to make fillings, using their regular technic, but with the instruments which we had been using in our laboratory. When we started four tests the next day after the dental meeting, we found that the mortar and pestle used at the meeting had been left in the traveling bag at home. We thought little about it at the time and proceeded to take another mortar and pestle from the shelf, where there were several. Much to our amazement, these tests showed from 2 to 4 microns more expansion than this alloy had been showing. An examination of the mortar and pestle which had been in use at the meeting and the substitutes chosen the next day revealed that the mortar and pestle formerly used were sandblasted and therefore quite rough, and the substitutes, of the same make and shape, were only ground on their surfaces and were therefore smoother. After checking the

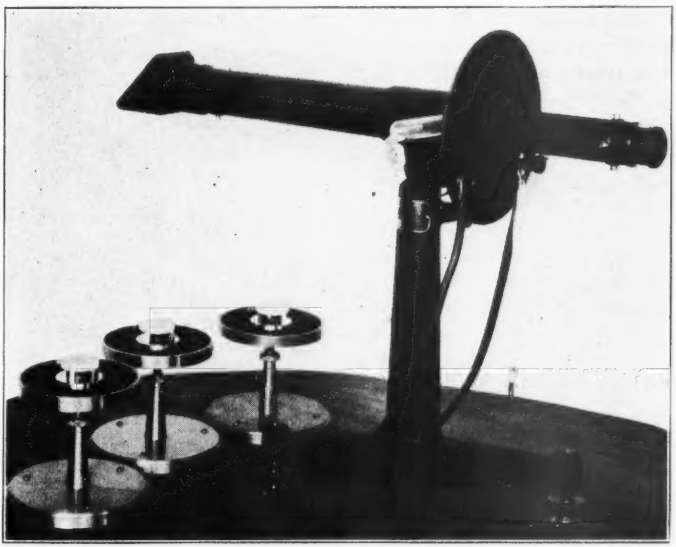


Fig. 2.—Three interferometers set under viewing apparatus. This arrangement, with the use of the optical micrometer, made possible the testing of four specimens simultaneously.

observation that the amalgam which was ground the most in the mortar expanded the least, we began a search of the literature to learn whether anyone else had observed that such little things as differences in the degree of roughness of the mortar and pestle would, with some alloys, produce variations in dimensional changes which were sufficiently large to determine their classification as acceptable or not acceptable. We were familiar, in a general way, with the work of all who had written anything on the subject which seemed to be supported by evidence obtained with modern instruments, but we were unable to recall

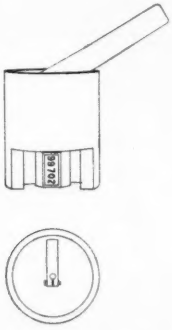


Fig. 3.—Metal mortar and pestle similar to glass mortar and pestle shown in Figure 4, but with speed indicator attached to under side.

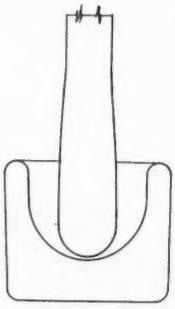


Fig. 4.—Glass mortar and pestle. (Compare Fig. 3.)

that anyone had recorded anything to indicate a knowledge of the subtle effect of such apparently small variations in manipulation, within the range of good practice, upon dimensional changes.

THE LITERATURE

The literature, previous to Black's work in 1895, did not seem to contain much of value in this study because of the primitive nature of the instruments that were used to determine dimensional changes. Black,[1] in a discussion of the influence of manipulation upon contraction and expansion in his original work, states that he could produce certain results at will and with certainty, but in order to do this so that the differences stood out prominently, "it seemed necessary to go out of the order of manipulation applicable in the filling of teeth." On the same page, in a discussion of the influence of packing, he says, "Pressure, however severe, that condenses the mass without kneading it tends to prevent shrinkage and any of the amalgams can be made to expand in setting, even those that with the ordinary manipulation contract the most, by using sufficient pressure that actually compresses the most without breaking it up."

In his textbook published in 1908, Black says:[2] "In the particular compound selected for use, shrinkage or expansion does not depend upon the proportion of mercury; further than that,

1. Black, G. V.: Physical Characteristics of Human Teeth, D. Cosmos 1895, 37: 656 (Aug.) 1895.

2. Black, G. V.: Operative Dentistry, Vol. 2, Chicago: Medico-Dental Publishing Company, p. 319.

wide shrinkages or wide expansions can be in some degree modified as to extent, not controlled. If these are only modifications and do not control, they are unimportant in the manipulative sense; the question of shrinkage and expansion resolves itself exclusively into that of the correct balancing of metals in the alloy."

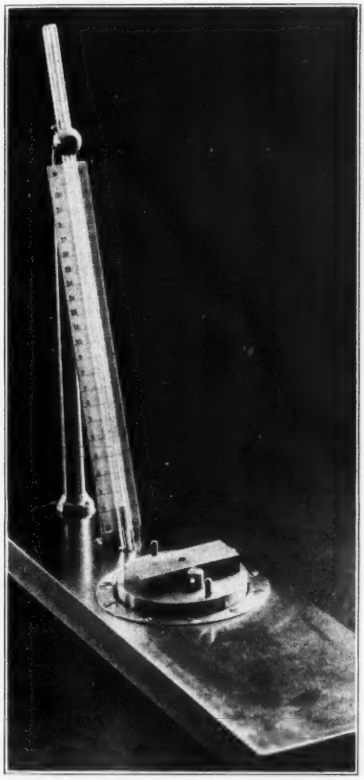


Fig. 5.—Packing-pressure gage (authors' design) on which split specimen formerly was mounted.

Souder and Peters [3] had stated, under the heading "Manipulation of Alloy," that "probably no other phase of the restoration is subject to greater carelessness." They also say, in the same article, "From the foregoing curves it is seen that the length of time devoted to mulling the amalgam exerted the greatest effect upon its subsequent behavior." Under the heading "Experimental Procedure," the same writers state that "experiments of this kind showed that large setting contractions could be produced in *any* of the amalgams by overmulling," and emphasized the importance of that part of the process. These statements had great significance to us at the beginning of our study on account of the known ability of the authors, and the well-known greater accuracy of their instruments over those used by Black. It was quite apparent that these workers were aware of the effects of excess trituration, but, as they showed in their dimensional change chart the results of only the one minute and the thirty-five minute mixes, we were without information as to whether these workers intended to imply that such excess trituration and mulling as is within the range of good practice (one and one-half to five minutes) would produce objectionable results.

Taylor [4] had stated that "undue prolongation of the time of mixing tends toward shrinkage." This statement, like similar ones made by Souder and Peters, was important for the same reasons as those given for the significance of the statements made by Souder and Peters, and, in addition, it furnished further confirmation that trituration and mulling were factors of great importance in connection with dimensional change measurements. The statement by Taylor, like those by Souder and

3. Bureau of Standards Technologic Paper No. 157, 1920.

4. Taylor, N. O.: Amalgam Technic, J. A. D. A., 17: 1886-1887 (Oct.) 1930.

Peters, did not indicate whether it was the belief that "undue prolongations" were included within the range of good practice. Moreover, neither Taylor nor Souder and Peters implied that there were exceptions such as are shown in our dimensional change chart on alloy No. 5, when the range for good practice is followed. Furthermore, none of these three workers had given any information about the reverse of the process; i. e., as to whether, if overtrituration and overmulling produce or tend to produce shrinkage, undertrituration and undermulling produce or tend to produce expansion.

Taylor [4] also had recorded some observations on the effect of different packing pressures up to 10 pounds on a 1.5 mm. plugger (presumably round), and

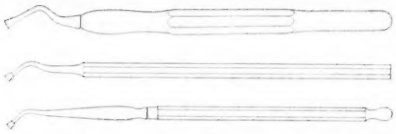


Fig. 6.—Pluggers used in experimentation on pressure. The one above was designed by the authors, the others being selected from the market.

had shown that shrinkage increased with increased packing pressure. He also stated that "as high pressures are reached, the setting changes in the resulting amalgams are more or less constant." This was an interesting statement to find at the beginning of the study, since Black had stated, several years previously, that increased packing pressure prevented shrinkage.

McBain and Knight [5] had stated that "in every case, amalgams of silver-tin alloys contract some days after amalgamation," and that this contraction is far greater when the amalgam has been imperfectly mixed." Their work was done with a glass dilatometer for the determination of dimensional changes and they used silver-tin combinations for their observations which have never been demonstrated to be the most desirable for the filling of teeth. For that reason, the work of these two men, while interesting from a chemical standpoint, was of little use to us.

Gray,[6] following the presentation of many interesting data obtained with modern instruments, under favorable conditions, had recorded the following:

"The determinations of both crushing

Fig. 7.—Plugger shown above in Figure 6, held in "pen grip" with finger support. It was found that with this plugger so held, some persons were able to exert pressures beyond the capacity of the authors' pressure gage.

strength and dimensional changes during hardening show how profoundly the behavior of an amalgam may be influenced by such things as mercury-alloy ratio, trituration time, packing pressure, temperature during hardening, temperature during testing, and age of amalgam, as well as by the characteristics of the particular alloy under test. Therefore, comparisons of different dental alloys are worth little unless it is shown that proper attention has been given to the con-

5. McBain, J. W., and Knight, W. A.: Physico-Chemical Properties of Amalgams, D. Cosmos 57: 639 (June) 1915.

6. Gray, A. W.: Metallographic Phenomena in Amalgams, J. N. D. A., 6: 920 (Oct.) 1919.

trol of all such factors. It is just because such control is lacking that we must discard as worthless a great many of the tests that have been made with the Black dynamometer and with the Black and other micrometers.

One of the authors[7] had stated under the heading "Volume Change" that "the recent work that has been done seems to prove beyond doubt that many of the same factors which control the behavior of other alloys control dental amalgams," and that "prominent among such factors are: packing pressure, packing time, trituration time, mercury alloy ratio, size of the alloy particles, temperature at which the dental amalgam is kept and age of the amalgam."

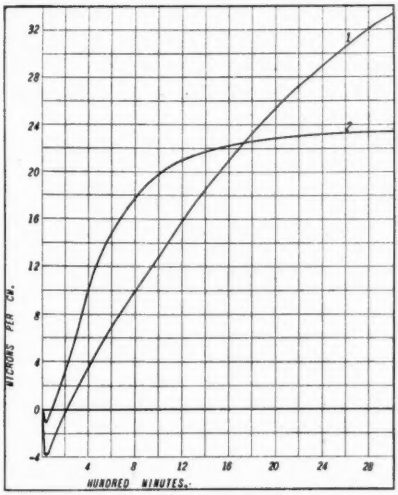


Fig. 8.—Variation in packing pressure: curve 1, alloy jarred into mold; curve 2, alloy under 500 pounds pressure per square inch.

At the beginning of this study, we had before us for consideration many other references to the subjects of dimensional change, crushing strength and flow that had appeared in the current literature and textbooks, but, as a rule, they were unsupported by adequate evidence, such as data obtained by the use of modern instruments. They are, therefore, not quoted here, as they would serve no useful purpose in the presentation of the results of our attempt to determine the effect of some of these variables when applied within the range of good practice. From the quotations given, it appears that the authors were all aware that variations in some of the factors in manipulation would influence dimensional changes, but it is interesting to observe how contradictory some of these statements are and how indefinite as to whether the variations occur within the range of good practice. What we wished to know was whether such variations as might occur with a two and one-half to three minute mix, which we used when we started to test our dimensional change apparatus with that at the Bureau of Standards, would enable us to place supposedly acceptable alloys in either an acceptable or a nonacceptable class. As will be seen later, this is what occurred when the alloys were made close to the zero point for dimensional changes, but it did not occur when they had a dimensional change range well above the zero point.

The literature seemed to suggest three things particularly:

1. There are variables which affect dimensional changes, and probably strength, but no one seems to have determined whether they lie within the range of good practice.

2. There was disagreement about how these variables affected dimensional changes.

3. No one seemed to know what we discovered later; namely, that it was

7. Ward, M. L.: American Textbook of Operative Dentistry, Ed. 6, Philadelphia: Lea & Febiger, 1926, p. 484.

the location of the dimensional change range which brought these variations within the range of good practice.

THE MORTAR AND PESTLE

Having reviewed the literature, we began a rather detailed study of the effect of using different speeds of the pestle in the mortar, and different grips of the pestle in the hand and of other variables, which will be enumerated later. During this study, we had in mind two things in particular which had occurred previously: (1) the failure of our instruments to check with each other to a satisfactory degree and with those of the Bureau of Standards for

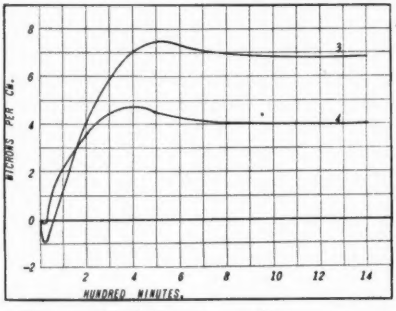


Fig. 9.—Variation in packing pressure: curve 3, alloy under 1,000 pounds pressure per square inch; curve 4, under 2,000 pounds per square inch.

dimensional change on two tests; and (2) our experience with the different mortar and pestle after the dental meeting. The question which naturally arose was: Is the failure of our instruments to check with the Bureau's and with one another due to differences in the shape and roughness of the mortars and pestles used or is it due to some other factors which are their equivalents?

After giving the matter further attention, we soon found that use of a smooth mortar and pestle for a little longer in the trituration process would produce the same effect on dimensional change as the use of a rough mortar and pestle for a shorter time. We then corresponded with a member of the staff at the Bureau and with the person in charge of the manufacture of one of the alloys involved in our failure to agree regarding the speed and time and type of mortar used in checking dimensional change for these alloys. The replies showed that, at the Bureau, approximately 125 r.p.m. of the pestle in the mortar were used, and at the factory where one alloy in question was made, approximately 60 r.p.m. were used. As the correspondence led us to believe that

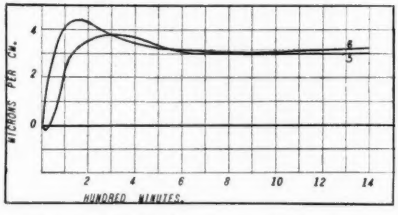


Fig. 10.—Variation in packing pressure: curve 5, alloy under 4,000 pounds pressure per square inch; curve 6, under 8,000 pounds pressure per square inch.

these speeds were approximate, we tried to approximate our own speed, and found that, without having given much attention to the matter, our speeds were subject to much variation.

We then went to our instrument maker and had him construct a metal mortar and pestle (Fig. 3) like the glass one (Fig. 4) that we were using, but with a speed indicator attached to the under side to enable us, with a stop watch, to study the habits of different persons in triturating. One of the first things to be observed was that we were using a speed of between 220 and 240

r.p.m. when using a pen grasp, but much less if the pestle were grasped with the entire hand, as is done when grinding, rather than mixing, is attempted. We then checked this observation with the manufacturer whose alloy was in question and found that he was using the full hand grip, as we had suspected, for we had not observed anyone using the pen grip who mixed as slowly as 60 r.p.m. We then took the speed indicator to two dental societies and asked the dentists to indicate their grip and speed as nearly as possible. We did the same with some of the faculty and students, and found that the differences which existed between the leading manufacturer, the Bureau of Standards and ourselves also existed among dentists, students and faculty.

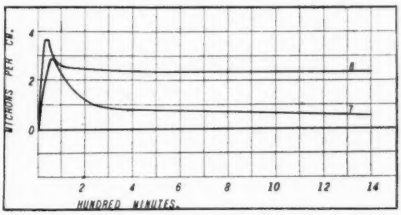


Fig. 11.—Variation in packing pressure: curve 7, alloy under 16,000 pounds pressure per square inch; curve 8, under 32,000 pounds pressure per square inch.

Moreover, we found that these differences in speed, grip, and shape of mortar and pestle were sufficient to enable us to place alloys made close to the zero point of dimensional change in either the acceptable or the nonacceptable class by increasing or decreasing the amount of work done on the alloy and mercury during the mixing and mulling process and by keeping our work well within the range of good practice. We could not do it, if the amalgam had a dimensional change range well above the zero point, similar to that shown later for alloy No. 5, and if we confined our variations to those commonly found in practice. If we went outside what is good practice, as Souder and Peters did, we might make any of the amalgams shrink, although it may be seen that, with such alloys as the No. 5 chosen for this study, it would require variations quite well outside good practice to result in a final shrinkage.

In all cases, including the No. 5 alloy, which had a final expansion of 4 microns with six minutes of working, we found that increasing the work in mixing and mulling by any means caused expanding amalgams to expand less and shrinking amalgams to shrink more. An amalgam which showed 1 or 2 microns expansion when a little work was done on it would, with more work, show at least 1 or 2 microns shrinkage. Souder and Peters had emphasized the effect of overmulling on shrinkage but had illustrated this effect by prolongations of the process beyond that of good practice. Taylor had stated that undue prolongation of the time of mixing tends toward shrinkage, but did not define

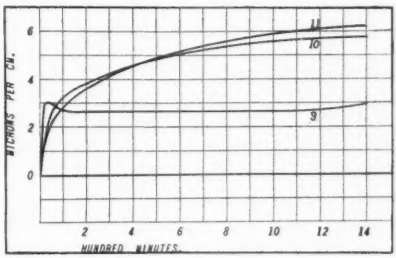


Fig. 12.—Variation in packing pressure: curve 9, alloy under 64,000 pounds pressure per square inch; curve 10, under 128,000 pounds pressure per square inch; curve 11, under 256,000 pounds pressure per square inch.

undue prolongation. Up to this point in our study, we had thought that there could probably be little doubt about the production of shrinkage with any of the alloys if the mixing and mulling were carried to ten or fifteen minutes, for the work of Souder and Peters and Taylor seemed to be quite convincing. What astonished us was to find that with amalgams which showed 1 or 2 microns expansion, and therefore complied with Specification No. 356, it required only an increase of from ten to thirty seconds, under the working conditions, to produce 2 or 3 microns shrinkage. From these experiences, we began to suspect

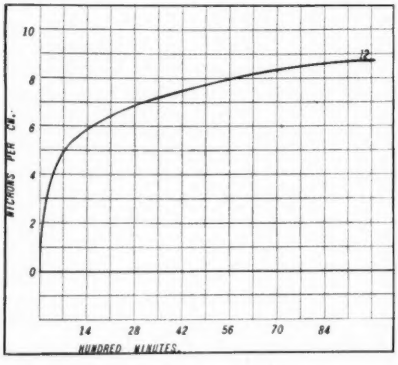


Fig. 13.—Variation in packing pressure: alloy under 256,000 pounds pressure per square inch (reading taken over a period of six days).

a thing which has become more and more evident as the study has progressed, i. e., that amalgams cannot be made so close to the zero point for dimensional change as Federal Specification No. 356 allows without danger of shrinkage if a little more work is done on the alloy and mercury than was intended.

With this accumulating knowledge of the effect on dimensional change of varying the amount of work done on the alloy and mercury in different ways, we concentrated on trying to make the three interferometers and the optical micrometer give the same readings when the same alloy and the same technic were used. We were able only partially to succeed, for, as we learned later, there were other uncontrolled factors that were varying the work being done on the alloy and mercury.

PACKING PRESSURE

We then undertook a study of the effect of varying packing pressures and their control. Taylor had shown that the amalgam which he used for packing pressure tests might have 18 microns expansion if vibrated into the specimen former with no hand pressure, but when the pressure in packing was increased to 8 pounds, with other conditions constant, it had neither expansion nor shrinkage. When it was malleted into place, it showed 1 micron shrinkage. It is assumed from what we know now that the pressure exerted in Taylor's

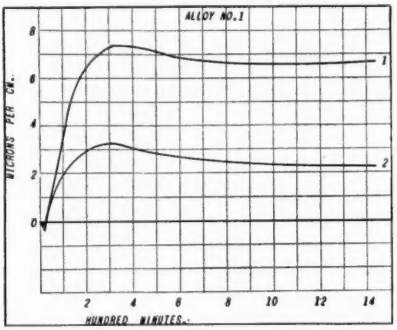


Fig. 14.—Effect of removal of mercury during mulling: curve 1, no mercury removed until just before packing; average quantity of mercury in packed specimens, 48.99 per cent; curve 2, mercury removed four times during mulling; average quantity of mercury in packed specimens, 47.72 per cent.

malleting was greater than the 8 pounds, and that the pressures up to 8 pounds were ordinary hand pressure with the ordinary hand instruments found in the market.

With this work as about the only guide available, we again called on the instrument maker of the university to construct a practical packing-pressure gage, of our design, upon which we could mount our split specimen former (Fig. 5). This pressure gage was made only 1 inch thick with a long base upon which the hand and forearm could rest, which made it possible for us to get greater uniformity than seemed possible with at least one other form of instrument that had been designed for this purpose.

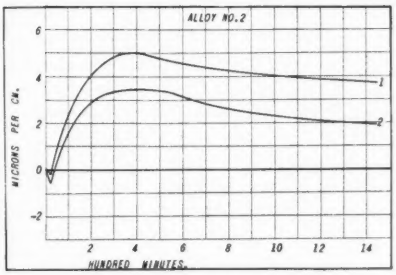


Fig. 15.—Effect of removal of mercury during mulling: curve 1, no mercury removed until just before packing; average quantity of mercury in packed specimens, 49.90 per cent; curve 2, mercury removed three times during mulling; average quantity of mercury in packed specimens, 49.20 per cent.

The same procedure was followed as with the speed meter; i. e., we made inquiry regarding the custom of others, and it was found that there were as great variations in the amount of pressure used in packing amalgam as there were in the work done on it in mixing and mulling the alloy and mercury. It was found that, in certain localities where gold foil fillings were still being inserted in considerable numbers, practitioners could be found who, without any special effort, exerted 20 pounds pressure, the capacity of the instrument. In other localities, where special attention was being given to hand work with chisels and similar instruments, there also were men who could exert 20 pounds. Taylor reported that some of the workers in the field, supposedly the cooperative committees for the Bureau of Standards, gave from 3 to 4 pounds as the average pressure obtainable with small pluggers, and stated that others reported that probably 2½ pounds pressure would be a better average.

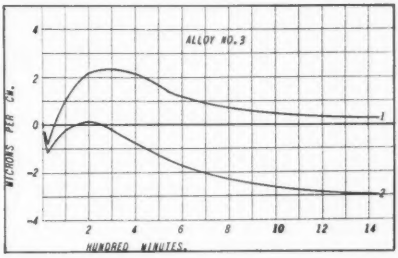


Fig. 16.—Effect of removal of mercury during mulling: curve 1, no mercury removed until just before packing; average quantity of mercury in packed specimens, 50.38 per cent; curve 2, mercury removed twice during mulling; average quantity of mercury in packed specimens, 49.46 per cent.

Since Taylor's experiences and ours were so different as regards the amount of pressure that certain persons could exert, we carried our experiments farther, with a view to determining whether other factors than muscular power entered into the problem. Occasionally, we would find a person who apparently had the muscular power necessary to exert the maximum pressure that the gage would register but

would let the packing instruments wobble as he attempted to exert pressure, and, as a result, the pressure exerted would be comparatively light.

This gave us an idea of at least one factor in cases of this kind that we had not considered. We then selected two different types of instruments from the market and had the instrument maker of the university make a third (Fig. 6). The two lower ones were selected from the market and the upper one was made by our instrument maker. We found that the average person could exert more pressure with the middle instrument than with the lower one, apparently for two reasons: (1) because with the lower one the portion of the handle to be gripped was too far from the face

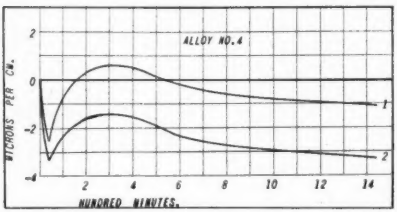


Fig. 17.—Effect of removal of mercury during mulling: curve 1, no mercury removed until just before packing; average quantity of mercury in packed specimens, 48.13 per cent; curve 2, mercury removed three times during mulling; average quantity of mercury in packed specimens, 47.71 per cent.

of the plugger, and (2) because the handle was smaller in diameter, which made it more difficult to hold. We found that, with the upper one, it was much easier for those who had trouble holding the instrument to exert normal and higher pressures. With the large handle, it is not necessary to grip very tightly to prevent wobbling when heavy pressure is exerted; while, with the small handled one, failure on the part of many persons to exert heavy pressure appears to be largely due to inability to grip tightly and exert heavy pressure at the same time.

Some persons have been observed who, with the upper instrument and a pen grip and finger support, such as is shown in Figure 7, can exert pressures beyond the capacity of our pressure gage. Such persons have such a strong grip that, with the advantage of the large handle and the shorter lever and finger support, they are wholly unconscious of the effort to hold the instrument. As a result, they throw their energy into the plugging operation with

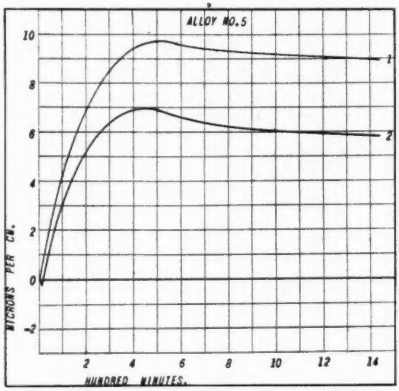


Fig. 18.—Effect of removal of mercury during mulling: curve 1, no mercury removed until just before packing; average quantity of mercury in packed specimens, 49.59 per cent; curve 2, mercury removed twice during mulling; average quantity of mercury in packed specimens, 48.81 per cent.

the ease of a graceful golfer. At one dental meeting, two or three dentists were observed who practiced hand plugging of gold foil. These men could, with little effort, exert an amount of pressure apparently well above the capacity of the pressure gage with the large handled instrument; for it was quite like the large handled hand gold

pluggers which they used so adroitly. With the small handled one, they could seldom, even with special effort to do so, exert pressure to the capacity of the instrument of 20 pounds.

It has been observed that with the use of instruments similar to the upper and middle ones shown, some persons would rest one of the fingers upon the bent portion, as shown in Figure 7. This fact, like the use of the large handle and shorter lever, added materially to the amount of pressure exerted.

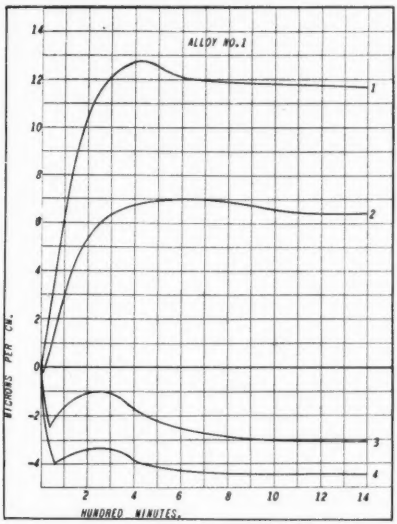


Fig. 19.—Effect of variation in mixing time: curve 1, twenty-five seconds in mortar, fifteen seconds in hand (undermix); curve 2, thirty-five seconds in mortar, sixty seconds in hand (normal mix); curve 3, sixty seconds in mortar, 120 seconds in hand (overmix); curve 4, ninety seconds in mortar, 150 seconds in hand (overmix).

This observation was probably of as much aid to us as anything we had learned about packing pressures; for we later learned that the exertion of uniform pressure upon specimens held upon the pressure gage was a difficult thing to accomplish, and this fact appears to us to explain, partially at least, why those who cooperated with the Bureau of Standards reported such low average pressures. Even with the low base pressure gage which made arm support possible, the large handled instrument, and the support of one finger upon the curve of the instrument, we found it impracticable to try to work closer than with a 2 pound range. It may be seen that, as a result, we adopted a 2 pound range for our work rather than a single pound. If we tried to raise the pressure more carefully so that we could stop the pressure at exactly a given pound mark, more time than usual was consumed and the mass thus allowed to stiffen and retain more mercury;

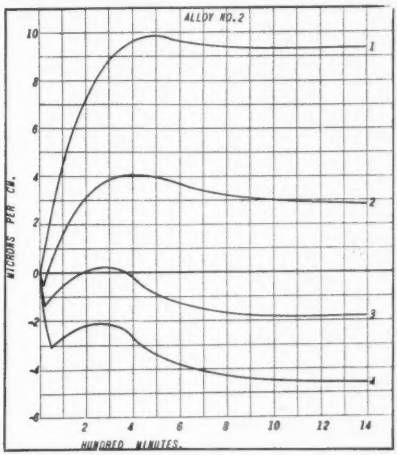


Fig. 20.—Effect of variation in mixing time: curve 1, thirty-five seconds in mortar, fifteen seconds in hand (undermix); curve 2, forty seconds in mortar, sixty seconds in hand (normal mix); curve 3, sixty seconds in mortar, 120 seconds in hand (overmix); curve 4, ninety seconds in mortar, 150 seconds in hand (overmix).

another variable being thereby introduced. The adoption of the 2 pound range seemed to be the practical solution of our problem and this practice has been followed throughout our work unless otherwise stated. Moreover, it appeared to us that since many practitioners were exerting from 18 to 20 pounds pressure, we should adopt not less than from 8 to 10 pounds for our work and this has been done except where otherwise stated.

Table 1 and Figures 8-13 present some of the principal data obtained in our studies of the effect of varying packing pressure on one of the high percentage silver alloys.

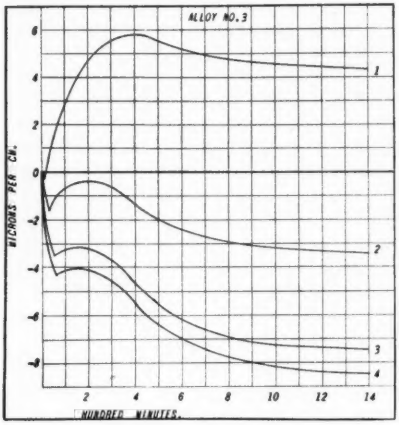


Fig. 21.—Effect of variation in mixing time: curve 1, forty seconds in mortar, fifteen seconds in hand (undermix); curve 2, fifty seconds in mortar, seventy-five seconds in hand (normal mix); curve 3, sixty seconds in mortar, 120 seconds in hand (overmix); curve 4, ninety seconds in mortar, 150 seconds in hand (overmix).

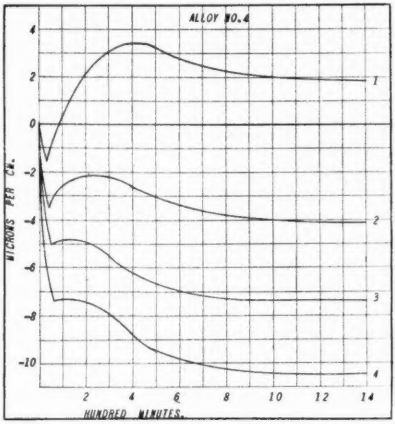


Fig. 22.—Effect of variation in mixing time: curve 1, twenty-five seconds in mortar, fifteen seconds in hand (undermix); curve 2, thirty-five seconds in mortar, sixty seconds in hand (normal mix); curve 3, sixty seconds in mortar, 120 seconds in hand (overmix); curve 4, ninety seconds in mortar, 150 seconds in hand (overmix).

CONCLUSIONS THAT MAY BE DRAWN FROM TABLE I AND GRAPHS (FIGS. 8-13) ON PACKING PRESSURE.

1. Expansion decreases with increased packing pressure from nothing to approximately 16,000 pounds per square inch.

2. At approximately 32,000 pounds pressure per square inch, expansion returns and increases with increase in packing pressures.

3. At some point between 64,000 and 128,000 pounds pressure per square inch, there is a distinctly different shaped curve of dimensional change showing further return of expansion, which continues for a period unknown to us. Our observations were limited to six days. The results of our work confirm that of Taylor up to approximately 16,000 pounds pressure per square inch and indicate that if Taylor had carried his pressures as high as we did, he might have discovered this interesting phenomenon, which seems to show that other agencies than a combination between mercury and silver to form the

compound Ag_3Hg_4 may be responsible for the dimensional changes which occur after 16,000 pounds pressure per square inch is reached.

4. Our results as shown by curves 1 and 2, Figure 8, and curve 12, Figure 13, would seem to indicate that the twenty-four-hour period of observation of dimensional changes provided for in Federal Specification No. 356 is not long enough to cover all of the conditions that

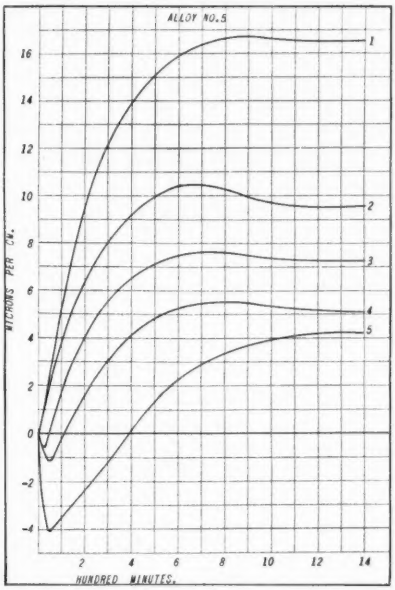


Fig. 23.—Effect of variation in mixing time: curve 1, thirty seconds in mortar, fifteen seconds in hand (undermix); curve 2, forty seconds in mortar, sixty seconds in hand (normal mix); curve 3, sixty seconds in mortar, 120 seconds in hand (overmix); curve 4, ninety seconds in mortar, 150 seconds in hand (overmix); curve 5, 120 seconds in mortar, 240 seconds in hand (overmix).

may be found in practice and in testing. In all three cases mentioned, dimensional changes were progressing beyond the twenty-four-hour period.

5. The percentage of mercury decreases with increase in packing pressure up to the maximum number of pounds that we used. These data would indicate that little, if any, reduction in percentage of mercury beyond 28.3 per cent could be produced by pressure.

It may be observed that no data are recorded in this table on crushing strength and flow. The ends of some of the specimens used for dimensional change were made smooth on a lathe and crushed, and were found to have a higher crushing resistance as the pressure was increased. As this seemed to be merely a confirmation of the work of several others, comparatively little attention was given to the fact except to note that, for the highest pressures, it was possible to produce with normal mixing a specimen with 73,000 pounds per square inch resistance.

The principal objective was to determine the effect of packing pressures on dimensional change, although an objective only a little less important was to determine the percentage of mercury retained in the set specimens. The work of Knight, McBain and Joiner, and several others, both abroad and in this country, had indicated that dimensional changes were closely associated with, if not dependent on, the amount of mercury available to form the compound Ag_3Hg_4. If observations were to be confined to such pressures as were used for curves 1 to 4, it would seem quite simple to associate expansion with the formation of the compound Ag_3Hg_4; for, in these cases, expansion increases and decreases with increase and decrease in percentages of mercury. Observations on curves 9 to 12 present a different situation; for a sharp change in the curve occurs and expansion begins and continues for some time while the per-

centage of mercury is diminishing. This seems to suggest either another reaction not yet known, or a purely physical change the result of the extremely high pressures used.

Since, with our lower packing pressures, a relationship seemed to exist between the percentage of mercury contained in the set specimen and the dimensional change, and as we were not quite satisfied with our ability to check our instruments, we decided to study

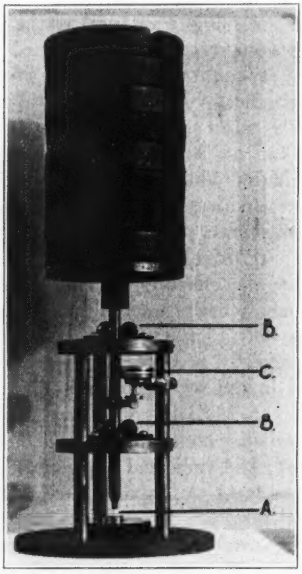


Fig. 24.—New type of flow testing instrument. *A*, specimen; *B*, triple ball bearings; *C*, horizontal micrometer.

the effect of the removal of mercury on dimensional change during the mulling process. The amount of mercury that was left in the set specimen had been quite accurately determined by analyses, but, with some alloys, we had found that the mass had become so soft, even though the directions of the manufacturer had been followed, that mulling in the hand was practically impossible. In such cases, we had been removing enough mercury during the mulling process to make the mulling easier.

A review of the literature seemed to offer little or no information on this point. During recent years, there apparently had been an inclination to advocate that plenty of mercury be used to make the mass coherent, but almost nothing had been said about the removal of any of it after the mass had become coherent and was turned into the hand for mulling. Moreover, nothing had been said about the fact that when the mass became very pasty, it would cling to the sides of the mortar and not remain under the pestle. The possibility of irregularities seemed to lie in mulling in the hand when the mass needed to have a certain consistency in order to be rolled around properly under the thumb and in the palm of the hand. In the following pages, reference will be made to the fact that, in some cases, we found it necessary to remove a little of the mercury in order to facilitate the mulling process. In order that we might remove any doubt that might exist about the effect of the use, during the mulling, of a little more mercury in some cases than in others, we decided to study the problem with five alloys chosen from the market from the list of high silver alloys that had been published by the Bureau of Standards, one of which we had used in our study of packing pressures. The composition of each is given in Table 2.

All five of these alloys were widely advertised and probably well known to the profession throughout the country. No. 1 was chosen because the filings and the mercury started to combine more quickly than in any of the other high

percentage silver alloys in the market, and because it contained such a small percentage of zinc. Alloy No. 2 was chosen because it contained a little more zinc than No. 1, and because the filings and mercury combined a little more slowly than they did with Alloy No. 1. Alloy No. 3 was chosen because, of all the high percentage silver alloys in the market, it contained one of the highest percentages of zinc and because the filings and the mercury were slowest to combine.

two other characteristics, one represented by alloys which were quicker setting and, as a result, inclined to be more crisp than those chosen, and another represented by the softest, most plastic and slowest setting of the high percentage alloys. Alloys No. 4 and 5 were chosen to meet these needs, No. 4 being the slow setting one and the No. 5 the quicker setting one. It appeared to us that these five alloys which we had chosen covered the market sufficiently well. We then proceded to our orig-

TABLE 1.—VARIATION OF DIMENSIONAL CHANGE AND MERCURY CONTENT WITH VARIATION OF PACKING PRESSURE*

Lbs. Pressure Per Sq. In.	Equivalent No. Lbs. on 2 Mm. Plugger		Dimensional Change	Percentage of Mercury
None	None	Jarred into specimen former..	See Curve 1, Fig. 8	59.89
500	2.43	Very light hand pressure.....	See Curve 2, Fig. 8	54.48
1,000	4.88	Light hand pressure.....	See Curve 3, Fig. 9	53.01
2,000	9.74	Heavy hand pressure.....	See Curve 4, Fig. 9	51.13
4,000	19.48	Very heavy hand pressure....	See Curve 5, Fig. 10	47.47
8,000	38.94	.....	See Curve 6, Fig. 10	44.37
16,000	77.90	.....	See Curve 7, Fig. 11	40.39
32,000	155.81	.....	See Curve 8, Fig. 11	34.75
64,000	311.61	.....	See Curve 9, Fig. 12	30.50
128,000	623.23	.....	See Curve 10, Fig. 12	28.32
256,000	1,246.47	.....	See Curve 11, Fig. 12	28.30

*Alloy No. 1, normal mix; machine packed with 4.31 mm. diameter plugger.

The first three alloys, therefore, represented progressive increases in the percentages of zinc, with more work to start the combination of the alloy with the filings. As our study up to this time had involved so many problems related to the amount of work done on the alloys, it appeared necessary that we choose three alloys with varying percentages of zinc in them and which had known characteristics that varied with respect to the amount of work required to make the alloy and filings combine.

Soon after the study began, we found that we needed to bring into the study

inal problem of trying to check our instruments with one another at the same time that we determined the effect of the removal of mercury during the mulling process.

Figures 14-18 indicate the behavior of these five alloys when mercury was removed during the mixing process and when it was not, with the other conditions in accordance with the descriptions which follow for the normal mix.

There are three principal conclusions which may be drawn from the graphs (Figs. 14-18) based on the removal of mercury during the mulling process

with the class of alloys chosen for this study:

1. When the previously determined proportions of mercury and alloy are used throughout the mixing and mulling processes, there is from 2 to 4 microns more expansion with alloys that expand than there is if mercury is removed during the mulling in the hand.

2. With alloys which shrink, there will be from 2 to 4 microns less shrinkage.

3. More mercury is retained in the set mass of amalgam when no mercury is removed during the mulling, provided other conditions are fixed.

TABLE 2.—COMPOSITION OF ALLOYS TESTED

	Per Cent by Weight				
	Silver	Tin	Copper	Zinc	Gold
Alloy No. 1	68.7	26.1	5.0	0.2	.....
Alloy No. 2	66.6	27.4	5.1	0.9	.....
Alloy No. 3	66.9	26.5	4.9	1.7	.....
Alloy No. 4	66.7	28.2	4.6	0.5	.....
Alloy No. 5	67.4	26.9	4.7	1.0	0.01

Our experience in studying packing pressures had shown that when little pressure was used, there was more mercury left in the set mass of amalgam, more expansion with alloys which expand and less shrinkage with those which shrank. It seemed, from these two studies, that the amount of mercury used in the mixing and mulling processes and the amount left in the set mass owing to low packing pressure or to some other condition, were vital factors in dimensional changes well within the range of everyday practice.

The results of our work on the type and roughness of the mortar and pestle, the speed with which the pestle was revolved in the mortar, the pressure of the pestle upon the alloy in the mortar, the time devoted to the mixing and mulling and the packing pressure, had indicated that they were all conditions, within the range of good practice, which affected the amount of work done on the alloy and mercury sufficiently to cause alloys made close to the zero point of dimensional change to be placed either in the acceptable or in the nonacceptable class.

Lack of control over everything having to do with the amount of work done during mixing and mulling, and everything having to do with the amount of mercury used during mixing and mulling, and the amount left in the finished specimen, seems to explain why we failed to agree on two of the specimens that were sent to us from the Bureau of Standards and why we found it futile to try to check our own instruments.

With control over these conditions, it now seemed that we were in a position to determine the effect of varying the time devoted to the mixing and mulling of the alloy and mercury. It appeared to us that there should be some conditions under which these products would show desirable dimensional changes, for the manufacturers of some of them were known to be well equipped for testing their products and were most reputable. It may be seen in what follows that some of the best known alloys in the market made by these manufacturers, some of them equipped with modern apparatus for testing, showed undesirable shrinkages with our technic, which we feel is well within the range of good practice.

We had been using a normal mix, so it now seemed desirable to learn the relationship between the time devoted to

mixing and mulling and the condition of the alloy by the development of an undermix and an overmix, both of which are based upon the relationship of time to the physical condition of the mass to make it suitable for packing. Especial attention is invited to item 5 under directions for the normal mix; for it appears to us that the production of a mass suitable for packing is the main consideration on which all directions for the use of amalgams should be based. If amalgam has been packed to make a tight filling, it appears perfectly obvious that strength and desirable dimensional changes are qualities that an amalgam should possess, for, if the physical condition of the mass of amalgam is not suitable for packing, it appears futile to attach much importance to other properties of the alloy, since the result will be a leaky filling.

DESCRIPTION OF UNDERMIX

The undermix is begun by placing weighed portions of alloy and mercury, determined by experiment and by the directions on the package, in a sand-blasted glass mortar and stirring with a sand-blasted glass pestle, the shape and dimensions of which are shown in Figure 4, at the rate of from 220 to 240 r. p. m., with a pen grasp of the pestle and with medium pressure.

As soon as the mass becomes coherent enough to be turned into the hand conveniently and quickly (which required, under the above named conditions, from twenty-five to forty seconds, this depending upon the alloy chosen, the size of the specimen to be formed and the size and shape of the particles of alloy), the time is carefully noted and taken as the minimum that it would be at all practicable to mix the alloy in the mortar. Without losing more than from five to ten seconds to change the mass from the mortar to the hand, the mass is then mulled in the hand with medium pressure at the rate of from 110 to 125 r. p. m. for from fifteen to twenty seconds. Within from five to ten seconds from the time the mulling is finished, the packing is begun. This is done by hand with a smooth flat-faced, circular 2 mm. diameter plugger, using from 8 to 10 pounds pressure, with the mold for forming the specimen held firmly upon the packing pressure gage (Fig. 5). The time consumed for packing the specimens for dimensional change tests and for flow tests is approximately one and one-half minutes, and for larger specimens for crushing strength, approximately two minutes.

After the mold has been packed with an excess of material and allowed to stand for approximately three minutes, the excess is removed by carefully shearing it off with a safety razor blade held in a suitable handle so that the specimen may be cut parallel with the top of the mold. The mold is now opened and the specimen is carefully revolved between the jaws of a special Brown and Sharp micrometer to make the specimen top and base parallel and 1 cm. in length, to comply with the Bureau of Standards Specification 356. Great care is exercised not to exert pressure on the specimen during handling. No mercury is removed during the mulling process, but, during the packing, the excess that appears at the top of the mass which is being packed is quickly removed with the plugger used for packing. Examination of the specimen, with a magnification of approximately 20, shows that there has been only a little breaking down of the particles of alloy. Twenty grains, or 1.296 gm., of alloy was used to make specimens for flow

tests; 25 grains, or 1.62 gm., to make specimens for dimensional change tests; 50 grains, or 3.24 gm., to make specimens for crushing strength tests.

DESCRIPTION OF NORMAL MIX

The normal mix is made under the same conditions and with the same care as the undermix, with the following exceptions:

1. The alloy and mercury are stirred in the mortar with the pestle beyond the point where they are coherent enough to be conveniently turned into the hand quickly, and to the point where the mass appears brighter in color than with the undermix. This requires, under the conditions mentioned, from thirty-five to fifty seconds, this depending on the same conditions as have been stated for the undermix.

2. The mass is mulled longer in the hand, until it may be rolled into the shape of a rod without breaking, but not until crepitus is observed. This requires, under the conditions mentioned, from sixty to seventy-five seconds, this depending on the alloy used and on the size of the mass being mulled.

3. Mercury is removed during the mulling if the mass becomes sloppy, by quickly increasing the pressure of the thumb upon the mix in the palm of the hand. This often occurs with some of the slower setting alloys that have a high percentage of silver.

4. Examination of the specimen reveals that there has been a considerable amount of breaking down of the alloy particles.

5. The principal consideration in the normal mix is the production of a mass that is suitable for packing. It is assumed that unless this object can be easily achieved by the average practitioner of dentistry, it is of little avail to produce a test specimen or a filling that has adequate strength or a minimum of dimensional change. Good practice seems to demand (1) a suitable cavity and (2) a tight filling. It is obviously very desirable that a tight filling inserted in a suitable cavity possess adequate strength and show a minimum of dimensional change. Neither one nor both of these qualities will assure success unless the mass of amalgam is first adapted tightly enough that there is no leakage when the filling is inserted.

DESCRIPTION OF THE OVERMIX

The overmix is made under the same conditions and with the same care as the undermix, with the following exceptions:

1. The alloy and mercury are stirred in the mortar with the pestle until the mass becomes pasty in appearance and adheres to the sides of the mortar. This requires, under the conditions mentioned, approximately one minute, but varies with the alloy chosen and with the same conditions as stated for the undermix.

2. The alloy and mercury are mulled in the hand until crepitus is just beginning. This requires, under the conditions mentioned, approximately two minutes, but varies a little with the alloy chosen and with the size of the mass being mulled.

3. Mercury is removed during the mulling if the mass becomes sloppy, and it usually does with the longer mixes, even if the alloy is not one of the slower setting ones.

To facilitate understanding what follows, it may be repeated that the principal difference between the overmix and the normal mix is that the overmix is pasty in the mortar, adheres to the sides of the mortar and shows beginning crepitus after mulling in the hand. More-

over, it may be well to point out at this time that the overmix, as we have used it, is approximately the three-minute mix, this period being mentioned so frequently in the literature as the desirable time to be devoted to the mixing and mulling of alloy and mercury for fillings.

The effect of the three different mixes on the five alloys chosen for study is shown in Figures 19-23.

The application of the three mixes to these five alloys, with the factors governing the amount of work done in affecting a combination of alloy and mercury under control and with control of the mercury used and retained in the specimen, seems to bring out several facts of importance to both manufacturers and practitioners. Before enumerating them, it seems advisable to invite attention to the following instructions in regard to the time required to affect a combination of alloy and mercury, as they have been taken from the literature of the manufacturers of these five alloys: No. 1 alloy, from two and one half to three minutes; No. 2 alloy, from two and one half to three minutes; No. 3 alloy, from two to two and one half minutes; No. 4 alloy, three minutes; No. 5 alloy, three minutes.

It may be noted that these data confirm the statements previously made that a three-minute period is generally accepted as good practice notwithstanding the fact that no one has given instructions about how the three minutes are to be occupied to prevent such great variations in the amount of work done on the alloy and, as a result, in dimensional changes as the graphs for these five alloys show.

It may be seen that with Alloy No. 1, 16 microns of dimensional change variation was obtained by varying the time of mixing and keeping the other factors constant; while, with the others, there was approximately 12 microns of dimensional change. Special attention is invited to curve 3 on each graph, which represents a shrinkage with the three-minute mix when four of the five alloys were used. Special attention is also invited to the behavior of Alloy No. 5. With this one, there was a final expansion of 4 microns when it had been mixed for six minutes under the same conditions as the others. Some allowance may be made for alloys No. 3 and No. 4, for they became a little too soft for good mulling when the specified ratio of alloy and mercury had been used and, as a result, a little mercury was removed during mulling. The dimensional change range for these alloys might be raised, therefore, 2 to 4 microns. If this adjustment in the dimensional change range is made, it will not place these alloys in the acceptable class when our three-minute mix has been used.

The behavior of Alloy No. 5 seems to indicate that alloys can be made which will remain in the acceptable class and not show shrinkage even when they are mixed as long as six minutes. The only approximation to a defect with this alloy, from a dimensional change standpoint, is that it comes near the 4-micron initial shrinkage provided for disqualification in Federal Specification No. 356 when it is mixed for six minutes. With the three-minute mix, this alloy showed an expansion of 7 microns, and with the four-minute mix, 5 microns. With both of these mixes, the initial shrinkage common to all of these alloys is reduced to well within the requirements of Federal Specification No. 356.

During the latter part of our study, we found in the market another alloy

which behaved in a manner similar to that of Alloy No. 5 in regard to dimensional change with overworking. Like the No. 5 alloy, this recently discovered one did not shrink with a three-minute mix such as we used in this study.

A significant factor in manufacture seems to be indicated in the graphs of dimensional change for these alloys. It may be observed that the graph for Alloy No. 5 shows its dimensional change range to be well above the zero point. This suggests that it would be advisable for the manufacturers of the other alloys to raise the dimensional change range to 4 or 5 microns as a minimum and 15 or 16 as a maximum, or to place directions on the packages which will enable the members of the profession to protect themselves against shrinkage when these products are used.

When one observes the time requirements for mixing and mulling that are given by the makers of these five alloys, and then observes what our application of these time requirements in our study did to four of the five of them, it would seem that the Bureau of Standards or some other reliable standardizing body should require the manufacturers to state specifically on the packages of their alloys the conditions under which these alloys will meet Federal specifications. To allow thousands of dentists to be deluded by a statement that an alloy meets Federal specifications, when, within the range of good practice, variations will result in objectionable shrinkage, is about as anomalous as the situation that exists today in regard to model alloys and their use. Some of the most generally used model alloys shrink as much as from 18 to 20 microns per centimeter with average manipulation. Little or nothing has been said about this, notwithstanding the Bureau of Standards and many members of the dental profession have recently been concerned about the expansion of waxes and investing materials to compensate for the shrinkage of the gold during cooling. It does not seem reasonable that the manufacturers do not know that they are selling products which will produce a model smaller than the pattern and are allowing the dentists to go through difficult and intricate technic which, in many cases, does not overcome the shrinkage of the amalgam model.

The situation that exists with the filling alloys and the model alloys with respect to dimensional changes is only a little different in principle from the one that exists with regard to that quality called strength. Some of the manufacturers have repeatedly advertised the number of pounds per square inch crushing resistance that their alloys possessed. In some instances, they have claimed superiority over competitors' products on the basis of strength, when they should know, and, if they wish to be helpful, should advise, that increasing strength beyond a certain point for each alloy may produce more flow and, as has been stated, produce shrinkage if the dimensional change ranges are not farther above the zero point than some of them are now. This is illustrated in Table 3, which gives the results of overmix, normal mix and undermix on crushing resistance and flow (Fig. 24) for the five alloys used for this study. The formulas for these have been previously given.

It may be observed that the longer the mixing and mulling, the higher the crushing resistance, with all five alloys. Under packing pressures, we pointed out that Alloy No. 1 yielded 73,000 pounds per square inch crushing resistance when

packed under extremely high pressure. Probably, no more generally understood information about amalgam exists than the foregoing statements that increasing the mixing and increasing the packing pressure increases crushing resistance. On the other hand, there is little information available about the property of flow (Fig. 24) and its relationship to crushing resistance. It would seem, from some of the manufacturer's statements, that the word "strength" covered all forms of resistance to stress. It seems to be a fact that the properties of crushing resistance and flow are not developed to a maximum at the same time. It may be seen from the chart that the increased mixing which brings out crushing strength increases flow with three of the five alloys. On the other hand, the No. 4 and No. 5 alloys, which did not prove so strong from a crushing resistance standpoint with overmixing, had, from the standpoint of flow, more strength with overmixing.

From these data, which have been gathered from a rather extensive study, it would appear that alloys which meet the Federal specification for crushing resistance may not meet it for flow if they are overworked a little; for, as shown with Alloy No. 1, as we developed crushing resistance beyond a certain point, we increased flow beyond that which is permitted by Federal Specification No. 356.

TABLE 3.—AVERAGE CRUSHING TESTS AND FLOW TESTS*

Crushing Tests in Pounds per Square Inch

	Undermix	Normal Mix	Overmix
Alloy No. 1	41,570	46,580	51,680
Alloy No. 2	35,100	44,470	51,567
Alloy No. 3	34,880	46,300	52,800
Alloy No. 4	34,200	47,500	48,200
Alloy No. 5	37,066	44,300	49,800

- Percentage of Flow

	Undermix	Normal Mix	Overmix
Alloy No. 1	5.25	3.53	7.06
Alloy No. 2	2.82	2.87	3.22
Alloy No. 3	3.57	3.04	4.07
Alloy No. 4	4.32	3.64	3.26
Alloy No. 5	3.38	2.77	3.28

*According to the Bureau of Standards Specification No. 356.

RELATING TOOTH POSITIONS IN FULL DENTURES TO THE ORAL VESTIBULE TO OBTAIN ACCURACY OF SPEECH, ESTHETICS AND ANATOMIC FUNCTION*

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EDUCATION of the laity to the importance of dentistry in relation to health has resulted in several interesting situations. Primarily, education has given the public an enquiring mind. Patients are not so much interested in whether restorations should be made as in what type of restoration is better as regards function and appearance.

In the field of full denture construction, the problem of appearance is increasing in its importance to the lay mind, together with the kind of material to be used in making the restoration. No longer can the operator expect to satisfy particular persons with dentures that are designed only for function and stability. There must be due regard given to appearance and to clarity of speech.

This paper will consider tooth position, (1) as to function in mastication; (2) as to appearance, and (3) as to speech or phonetics. Stability of the denture bases and balance of the occlusion are accepted as being accomplished.

As regards positioning of teeth, masticatory function, esthetics and speech are in part interdependent and are developed as a unit. Positioning is here analyzed separately under each head for a clearer understanding of each one, but is subsequently applied to the three in considering the restoration.

Tooth position in relation to masticatory function involves two leverage problems: (1) the distance of the teeth vertically from the ridge center and (2) the distance of the teeth horizontally from the ridge center. The greater the vertical distance from the ridge, the greater the leverage from a diagonal force applied from within the denture area. The greater the buccal distance horizontally from the ridge center, the greater the leverage from a vertical force. In each instance, the length of the lever arm is the distance from the ridge center to the occlusal surface of the tooth. Teeth should therefore be kept as close to the ridge center as is possible. These two leverage problems function before the teeth make contact, and are hence not a factor in balancing occlusion.

An additional principle of tooth position in relation to function is the coordination of the tongue, teeth and buccal and labial tissues necessary to control a bolus of food.

The mandible is a moving arm carrying food to a fixed member, the maxillary teeth, for crushing and grinding. Control of the food bolus is maintained by the tongue, cheeks and lips coordinating with the teeth, holding and changing the bolus as required. If the mandibular

*Read before the Section on Full Denture Prosthesis at the Seventy-Third Annual Session of the American Dental Association, Memphis, Tenn., Oct. 22, 1931.

posterior teeth are placed too high, the tongue is confined as in a box and cannot assist the cheeks and lips in controlling the bolus of food.

Nature has so designed the posterior teeth that when they are in the vertical position the occlusal surfaces will be about on a level or one-eighth inch below the dorsal surface of the tongue at rest. The preceding is to be considered in contouring the occlusion rims.

The second factor in tooth position has reference to esthetics. It is suggested that the term "natural appearance" would cause less mental confusion as to the desired objective than the word "esthetics," and future reference in this paper to esthetics will employ this term.

Natural appearance of full dentures is obtained by selecting tooth forms that harmonize with face form and, by judicious grinding, these forms are individualized; by determining the hue for complexion types and modifying by staining to duplicate natural defects or peculiarities that existed in the natural teeth, and by alining or arranging according to the particular face and arch form. Furthermore, unnatural facial lines and contours must be eliminated by opening the bite; which involves positioning the teeth.

Before arranging or setting the teeth for natural appearance, it is necessary to start with occlusion rims that establish the correct facial dimensions and facial contours. Experience and study are really the best guide as to the correct distance to open the bite, although numerous ways have been devised for its determination. Among the devices are facial masks; wire profile contours, from which is made a cardboard profile mask, and photographs of the individual in early maturity, from which a problem in proportion is obtained, and measurements that are made from certain fixed landmarks on the face before extraction. These are all beneficial, at least as a starting point from which the contours and dimensions are modified. The various methods have been fully described in current literature for several years. The basic idea is to remember that facial expression is controlled by maintaining or restoring the muscle tension that existed when the natural teeth were normally present. Closing the bite causes a shortening and thickening of the muscle fibers with a change in the direction of tension force. This causes a relaxation of the surface tissue, with the formation of a fold or wrinkle. The wrinkles form at right angles to the direction of the muscular tension. Humbert de Superville has demonstrated this action by photographic records taken when a particular muscle had been contracted by applying an electric current. Correct bite opening is therefore important, as it determines the vertical positions of the teeth and aids in restoring normal facial expression.

The labial position of the anterior teeth for natural appearance is determined by the profile type. The straight profile produces a normal overjet; the convex a greater overjet, and the concave an end-to-end relation. These are associated as a rule with the normal, orthognathous and prognathous anterior ridge relations. When teeth are set to conform to these conditions, only a minor change is usually necessary.

The type of arrangement is dependent on the face form. No particular alinement should be followed beyond the basic formula. A square arch as a rule is regular or spaced, with the bicuspids in line with the cuspid. An ovoid arch is rounding, lateral incisions may be overlapped or underlapped, with the central

incisions and the bicuspids slightly buccally from the cuspid. The tapering arch may have any variety of irregularities with the bicuspids lingually from the cuspid. A series of models and photographs with the various arrangements of the natural teeth for the different arch forms are the best means of preventing stereotyped results.

In all, when a radical change is contemplated, it is well to remember that facial contour work is a form of plastic surgery, without a surgical procedure. The face of an individual is the most vulnerable portion of the body. Plastic surgeons recognize this, and because they cannot rectify a result, they usually request their fee in advance. An excellent restoration may be disappointing to the patient, because it is different from the expression they and their family are accustomed to.

Denture restorations may produce appearances that, for the first few weeks, are strained and unnatural. The teeth seem too prominent and lines in the face are still apparent. Facial contour work means developing tissue and time is required to produce the desired effect. If the operator is not entirely familiar with changes that can be accomplished and cannot secure the enthusiastic cooperation of the patient, no radical change should be attempted, or the case should be referred to a specialist. Study and experience only can teach the fine details of correcting facial expression.

In analyzing clarity of speech, it is necessary to review its mechanical reproduction. Voice sound depends on the proper functioning of four mechanisms: (1) the motor; (2) the vibrator; (3) the resonator, and (4) the enunciator. There is a fifth mechanism that should be considered in studying defective speech: the motor speech area of the brain, and the nerves which convey to the speech organs the motor speech impulses. It is important in denture prosthesis only in that patients who are of a neurotic type or suffer any nervous affliction will be very slow in correcting any speech defects due to dentures. They should be more carefully instructed as to enunciation. Also, the length of time for correction is increased. The motor is the lungs that supply the breath. The vibrator is the vocal cords, the activity of which gives pitch to the tone. The resonators are the cavities of the mouth, the throat and the accessory nasal sinuses in the head, which give quality. The enunciators or articulators are the lips, the tongue, the uvula, the soft palate and the teeth. The teeth and other enunciators form obstructions to the passage of the breath, breaking up the tones, and thus produce individual sounds or speech.

As the breath issues from the larynx, it is broken up into two streams of air. This is accomplished by the uvula and soft palate. The upper air stream is used in speech only for the sounds "n" "m" and "ng." This upper air stream is the one used for true resonance in singing. All other sounds are produced in the lower breath stream as it strikes the palate. Hence, speech is a function of the enunciators; whereas, pure sound is laryngeal in production.

The soft palate is important because, in all speech sound except n, m and ng, the soft palate must rise and close the nasopharyngeal space. If the soft palate is inactive, the control of the air volume is lost, and the tone becomes guttural and wooden. A denture sometimes causes irritation of the soft palate, with a stiffening of the palatal muscles, caus-

ing an inactivity of the soft palate and uvula which will make enunciation difficult. The first experience with dentures will also, in a few patients, produce an unconscious tightening of the entire masticatory apparatus; which will give the same result. Relaxation and freedom of the voice mechanism are essential for clear enunciation, and the patient should be so instructed. An inactive soft palate should be stimulated by digital massage or by a faradic palatomasseur. Helpful exercises are yawning, together with saying the familiar ah-h-h. The prime requisite to clarify the speech is relaxation and routine practice in forming the letter or words that are difficult. In the schools of defective speech, it has been found that regular daily practice will overcome most minor defects and greatly improve even gross conditions that cannot be corrected by surgery.

While the teeth do not make active obstructive movements to the clear passage of the breath, their very presence is a hindrance, and absence or malposition of the teeth causes an unnecessary escape of air. This escape of air produces a defective pronunciation of certain sounds.

The vowel sounds "a," "e" and "i" are pronounced with the front of the tongue raised toward the palate, forming a place of constriction at the front of the mouth. The sound "o" is made with the base of the tongue raised toward the palate. The vowel "u" is sounded midway between "a," etc., and "o." In all vowels, tongue control is not difficult and no particular attention need be given to tooth position.

The consonants and their combinations are greatly modified or clarified by correct tooth position. The dental consonants are d, t, l, r, s, j and w.

Of the dental consonants, the letters "d," "t," "s" and the diphthong "th" are most affected by tooth position. The letters "t" and "d" are formed by the tip of the tongue, starting on the lingual surfaces of the upper anterior teeth and leaving with an explosive sound.

The sound "s" is formed by the sides of the tongue in contact with the upper posterior teeth; the tongue depressed in the middle; the soft palate closing the nasopharyngeal space, and the tip of the tongue making contact with the lingual surfaces of the upper anterior teeth at the finish of the sound. The tip of the tongue starts on the lingual surface on the lower anterior teeth and ends on the lingual surface of the upper anterior teeth. Hence, too great an overjet or spacing of the upper and lower anterior teeth leaves too open an area, allowing the air to escape in a hissing or whistling sound. This may be due either to the upper anterior teeth being too far forward, or, as in an orthognathous case, the lower anterior teeth being too far distally.

To form the diphthong "th" sound, the tip of the tongue makes contact with the lingual surfaces of the upper anterior teeth, also with the rugae area. The sides of the tongue make contact with the upper posterior teeth. This forms an air channel and the tip of the tongue in making or breaking the contact causes the clear enunciation of the sounding. If the anterior teeth are too widely spaced; if the rugae area contour is incorrect; if lingual carvings are excessive, or if any irregularity or malposition of the teeth is too exaggerated, sealing the air channel and controlling the air with the tongue will be lost and a hissing sound will result.

The aspirate consonant "h" requires little attention as a separate sound, for it follows a formation similar to that of the vowels.

In forming the gutturals "g" and "k," the base of the tongue and soft palate only are to be considered, as these letters are formed in the posterior area of the mouth.

As the labials "b," "p," "w" and "m" are formed on the lips, freedom of lip contact is the only factor to consider.

It is perhaps in the labiodentals that the greatest number of defects may be located. The letters "f" and "v" are formed by the lower lip contacting with the upper anterior teeth. Positioning the lower anterior teeth too far forward, and too high, with the upper anterior teeth too short, makes the meeting of the lower lip and upper anterior teeth difficult. The result will be an indistinct sound with no particular character and might be mistaken for s, t or th.

The lip action should be free, as production of the sounds "s," "n," "t," "f" and "v" requires the raising of the upper lip. A series of exercises such as smiling, whistling, wrinkling the nose, raising the upper lip and pulling down the lower lip will relax these tissues.

The preceding are basic principles of tooth position as related to masticatory function, natural appearance and speech. In their application to constructing a set of dentures, they are considered together and modifications made as the case demands.

Let it be assumed that the contour rims are constructed and the operator is ready to restore facial dimensions and contours. In procedure, the upper contour and length are first restored. The contour is determined by the profile type. A straight profile calls for the upper lip to be on a line with the supra-orbital notch and the symphysis. If this brings the anterior teeth too far from the crest of the ridge, it may be necessary to sacrifice something in appearance for stability, and this is determined by the desires of the patient. If masks or records of any nature are used, this contour is molded to the records. The length of the anterior teeth is determined from previous records or from a study of the case. A case in which a lip has become shortened owing to closing of the bite or the patient's being without dentures will at rest require more tooth showing than in a normal case. The average length is about one-sixteenth inch below the lip line at rest.

The plane of occlusion anteriorly is paralleled to a line through the pupils of the eyes, but the anterior-posterior plane is not considered at this time. The upper contour rim is now set aside and the lower is placed in position to determine the height of the lower posterior teeth. Starting from the cuspid position, the height is established distally to a level with the dorsal surface of the tongue when at rest.

The two contour rims are now placed in the mouth together. The anterior length of the upper and the posterior height of the lower have been established. The facial dimension is established by adding or removing wax on the anterior length of the lower until the bite-opening conforms to the measurements; and by the use of profile masks or facial masks that have previously been taken. This will give the height of the lower anterior teeth. The labial surface of the wax is contoured to conform to the position of the lower anterior teeth, with the ridge crest as the aim, to prevent leverage, and the gingival margins in more than is the incisal edge in order to give

the lip contour. When this is correct in the straight profile type, the lips will be about on a line and the correct opening will give approximately a straight lip line.

When the lower facial third has been thus established, the posterior occlusal plane of the upper is established and pressure is equalized by adding or removing wax from the posterior plane until the patient closes evenly on the entire surface of the occlusion rims.

The completion of this step is made by placing abrasive paste between the contour rims and instructing the patient to slide them gently in all positions. The usual records of median line, high and low lip line and the corners of the mouth are made on the contour models.

When the teeth have been selected, centric relation is established and the case is mounted on the articulator.

The upper anterior teeth are set by cutting away the wax and restoring the contour rim with the teeth in the alinement as determined from arrangement of the natural teeth or according to face form and arch form. In setting the teeth, a good procedure is to set the two central incisors, the two lateral incisors and then the cuspids. It is easier for the eye to determine better symmetry and balance in this manner than by setting first one-half and then the other.

If there is any doubt as to arrangement or tooth selection, it is better to set the lower anterior teeth next and try the case in before proceeding with the posterior teeth. In setting the lower anterior teeth, the first consideration is the leverage. Care should be taken that the teeth are not set too far forward of the ridge center. The gingival margin should be well back on the ridge incisal edges, inclined labially to allow for lower lip contour, except for the cuspids, which are set with the gingival aspect out or the tooth straight to give a better support at the corners of the mouth.

When the case is normal and no doubt exists as to whether the size, form and color of the teeth is correct, the entire denture is set up before tried in. The bicuspids and molars are set with consideration (1) to leverage, (2) to arch form and (3) to tongue space and freedom.

The upper posterior teeth are set in position before the lower posterior teeth. This is determined by graving a line on the lower occlusion rim that passes through the center of the lower ridge. The central grooves of the bicuspids and molars are placed over this line on the lower denture, with the modifications required by the type of arch arrangement. Tongue space, irregular arches and appearance will at times cause a deviation from this rule, but it is a guide and the necessary compromise of position is easier to determine. The dentures are not balanced until speech and appearance have been tested in the mouth.

The trial dentures should be firmly held in position if the test is to be of any value. It is not unethical to use powder to facilitate firmness.

The patient should have the head in an upright position, almost on a level with the eyes, and should relax face and all neck muscles. This is important, for without relaxation throaty and wooden tones only are possible. Appearance, as to size, arrangement, hue and symmetry, is considered. The rule for curved lines paralleling applies to the lower lip line in smiling and the line of the six upper anterior teeth. This is an old rule, but often forgotten. The

fulness of the upper and lower lips; the angles of the mouth; the dimension of the lower third of the face; the prominence of the teeth, and the arch form are observed. If the preceding are pleasing, the test is made for speech.

Any series of words or sentences may be employed that call for use of the letters that are difficult. The final test should be made on the letter alone. I usually have the patient relate their mental reactions when it was first learned that artificial dentures would be necessary. At this time, explanations regarding proposed tissue changes and the manner in which speech is clarified are usually given to the patient. This causes relaxation, and grosser defects will be noted at once.

The letters "f," "v," "p," "b" and "m" are usually tested first because they established the position of the anterior teeth and the ability of the lips to come in contact. A faulty b, p or m shows a bite opening that is too great or, in an exaggerated case, upper and lower anterior teeth unduly protruding forward of the ridges. If the letter "f" or "v" is indistinct, this probably is due to the upper anterior teeth being too short and the lower anterior too high and too far forward. This is the most common error made in phonetics. These positions must be changed so that the lower lip may freely meet the upper anterior teeth, and the escape of air be prevented.

The second frequent error is in relation to the letter "s." An extremely broad upper arch position might cause the escape of air along the blade of the tongue, but a faulty sound is usually caused by too great an overjet between the upper and lower anterior teeth. The lower anterior teeth are too short or are so far distally that the tongue cannot control them. Changing the positions and closing this space will correct the "s" sound.

The difficulty with the diphthong "th" is due to improper formation of the rugae area. A natural contour with no great space between the upper anterior teeth will correct this defect.

A decided constriction of the arch or an inactive soft palate will cause a "mouthiness" and a hollow tone. If the letters test singly and then in words and sentences, the speech, with practice, will clarify in a few days.

CONCLUSION

It is maintained that tooth position is important to masticatory function because of leverage and coordination between tongue, lips, cheeks and the teeth in control of food. Tooth position is important to the appearance because it determines facial dimensions and facial contour, and also controls enunciation and assists in resonance.

It is observed that masticatory function, natural appearance and speech are closely related, and at times it is necessary to modify one for the sake of the other. If esthetics and speech call for the teeth being too far labially or buccally, it is necessary to sacrifice either stability or appearance, and the patient should be informed and asked to decide which seems most important. Ideals are only attained in dreams; the land of Arcadia is still a myth, and artificial dentures are not natural teeth.

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DISCUSSION

E. B. Owen, St. Louis, Mo.—In the trinity of function, comfort and appearance in full dentures, we can no longer disregard appearance as an important factor. In fact, no set of dentures is complete without all three of these requisites. Function and comfort are products of mechanical procedure, but restoration of harmonious facial relations is an artistic accomplishment and classifies our ef-

forts as a professional service. Education of patients to a greater appreciation of esthetics is commendable, and I devote considerable time to that task, but I do not lay too much stress on materials as that detracts somewhat from the professional aspect. Of late, it has become necessary to answer certain questions of patients regarding materials that have been advocated by others. In such cases, I give the patient full information as to what may be expected of the new natural colored materials in which they are interested. It is to be expected that patients will desire natural colored materials, which enhance the beauty of the denture, but it is the height of folly for us to build high hopes in their minds regarding the beauty of certain materials when the materials will not fulfil their expectations. Many times, no doubt, for the sake of a higher fee, dentures of a pleasing color are exhibited to a patient, without an explanation regarding its possible shortcomings. This often results in disappointment of the patient and lowers his estimation of the dentist and the dental profession. No material of a questionable nature should be used unless in a way that will not bring disappointment to the patient nor cause the dentist subsequent embarrassment and expense. One cannot emphasize too much the importance of leverage as brought out by Dr. Weir. I might add that it applies mostly to the posterior teeth. For the sake of appearance, we may, and often do, in arranging the anterior teeth, deviate from the rule of staying directly over or under the ridge. Regardless of how the anterior teeth are set, unless they are inclined posteriorly, one cannot incise in the ordinary way that natural teeth are used, that is, by directing the applied leverage outward, but they have to be trained to apply the leverage in incising so its direction is inward, in order not to upset the dentures. This may be done regardless of how far the anterior teeth are from the ridge or how long they are. This permits us to take such liberties with the anterior teeth as are necessary to restore a pleasing appearance. Establishing an approximately correct opening of the jaws, as emphasized by Dr. Weir, is very desirable and such things as cardboard masks, profile measurements and photographs are sometimes helpful; but, after all is said and done, one's own judgment is the important factor. Opening the bite, regardless of the distance, merely with esthetics in mind, is, in my opinion, often harmful, and the practice has been carried to extreme degrees by some prosthetists. The dangers attendant on the practice are: getting the posterior teeth too far from their ridges; causing excessive leverage and consequent destruction of supporting bases, and getting the lower posterior teeth too high above the tongue and thus impairing the function of that organ and dislodging the lower denture. When the teeth, either posterior or anterior, are too long, they become a factor in impeding speech. My guides in the step of opening the jaws are the length of the lips and the height of the lower posterior teeth in relation to the tongue. I do not in all cases try to eliminate all lines in the face by opening the jaws. In many cases, this would result in too much opening for comfort, produce awkwardness in the use of the dentures that the patient may never overcome and cause dissatisfaction in general. In order that we may not let enthusiasm overcome our better judgment, it is well to bear in mind that those cases that have come under our observation of dentures having been worn for twenty or thirty years with comfort and no apparent damage to the supporting ridges, are all built "close to the ground." Do not construe these remarks as meaning that I am opposed to opening the jaws when necessary, but rather that common sense and experience, and not enthusiasm to remove all lines and wrinkles, should be our guide. Impairment of speech by artificial dentures has been the source of much study, as certain conditions seem to bother some people and do not affect others. Dr. Weir has made an exhaustive study of this subject. Such impairment of the speech as has been encountered in my office may be limited to two conditions: "mushiness" of the voice, and lisping or whistling. I believe these are by far the most common defects. Mushiness is caused by several different conditions. If the uvula or vibrating soft palate is tied down by an overextension of the posterior margin of the denture, this condition may result. Extension, posteriorly or vertically downward, on the lingual flange of a lower denture, tying down the tongue muscles, is also a factor in mushiness. This condition may also result from having the posterior teeth, either upper or lower, too long or too narrow, impairing the function of the

tongue and causing self-consciousness on the part of the patient, preventing relaxation. This particular impairment of the voice is frequently observed during the first day, or perhaps two or three days, this depending on the personal equation, and then disappears. For that period of time, the wearer does not relax, and the dentures are a foreign body in the mouth. Excessive flow of saliva also frequently results from the same conditions, but as the dentures become a part of the patient and begin to feel natural, the patient relaxes and the trouble usually disappears. The other serious impediment, that of whistling, seems more difficult to understand. It is the one in which the anterior teeth play the greater part. Dr. Weir has given definite rules as to the placing of the anterior teeth in their relation to the tongue and lips, as the result of much study of the mechanics of sound production and control in the mouth, but it is not always easy to set anterior teeth with a view to producing correct articulation alone. When the teeth are tried in the mouth, if they are too long or too short, in too far or out too far, too even or too irregular, according to the patient's point of view there is nothing to do but change them. You may argue that if the teeth are changed, the articulation may not be so good, but a patient "convinced against his will is of the same opinion still," and will wonder why you can't meet both conditions. Fortunately, the adaptability of human beings to almost any conceivable condition many times helps us out of what might be an embarrassing situation. Demosthenes, in order to make articulation and public speaking easier, filled his mouth with pebbles and orated to the waves until he was able to speak distinctly, which illustrates our adaptability to unnatural conditions. Patients learn to articulate clearly without any teeth at all, utilizing the anterior part of the gum instead of the lingual surfaces of the teeth. They learn to talk with almost any arrangement or irregularity of the teeth. Recently, I saw a gold denture with the finishing rim entirely too far anteriorly and this condition, coupled with a slight lingual inclination of the anterior teeth, made a small cave in the anterior part of the vault; a very unnatural condition. This patient could articulate clearly. I have seen other persons with teeth apparently normally arranged who, when talking, reminded one of a canary. I have also seen this same condition in people who have their natural teeth. Close study and observation reveals some causes for whistling. I find that, in the extremely long lipped person who has been wearing teeth entirely too short, placing dentures in the mouth in the correct relation to the lip and thus giving the patient a much deeper vault than he has been accustomed to frequently causes a lisping that is very hard to overcome. This defect of speech frequently occurs also in the V-shaped type where there is considerable overjet. I believe that Dr. Weir's paper and study of this subject will prove of great help, although my greatest aid, as is yours, is the adaptability of human beings to almost any condition. Esthetics, therefore, is my chief guide in arranging the anterior teeth.

FLUORIN CONTENT OF CERTAIN WATERS IN RELATION TO THE PRODUCTION OF MOTTLED ENAMEL*

By FREDERICK S. McKAY, D.D.S., New York City

THAT lesion of the enamel to which the designation "mottled" was applied by G. V. Black was first described in dental literature in 1916.[1] The investigation seeking to determine the conditions under which it occurs, its geographic distribution, and the factors in its production was begun in 1908.

The aspect of this lesion which stamps it as being unique is the limitation of its occurrence to geographic areas that are sharply defined. In some instances disclosed during the investigation, communities suffering 100 per cent affliction and others totally immune exist not more than 4 or 5 miles apart.

The astounding selectivity of this lesion is another phase of its unique character, only such enamel of the permanent teeth, or such portions of the enamel, as is grown or developed during residence in an afflicted district being affected. Almost without exception all enamel developed within such a district will display this lesion, and, conversely, enamel grown outside such a district will never under any circumstances become mottled should the individual later become a resident of an afflicted district.

The temporary teeth have been found to be affected very rarely, and then only the molars, and very slightly.

At the time the investigation was begun, those undertaking it knew of only one afflicted district in the world. The present known geographic distribution of mottled enamel is set forth in brief outline in a recent publication.[2] Its clinical appearance has been illustrated many times in the periodical literature of dentistry during the course of the investigation.

By inference, it becomes clear that, at the time the investigation was begun, no shadow of a theory existed that could offer a reasonable explanation of its cause, or point to a remedial measure. The sharp geographic definitions of its distribution pointed with more than a suspicion to some influence or condition that operated locally, and was hence locally produced.

Indeed, circumstances appeared during the investigation which focused the problem down to definite spots within the circle of a given community; on such "spots," or, to be more explicit, certain homesteads, some condition operated which produced mottling of the enamel

*Read before the Section on Research and Biologic Sciences at the Midwinter Clinic of the Chicago Dental Society, Jan. 19, 1932.

1. Black, G. V., and McKay, F. S.: Mottled Teeth: An Endemic Developmental Imperfection of Teeth Heretofore Unknown in Literature of Dentistry, D. Cosmos, 58:129 (Feb.), 477 (May), 627 (June), 781 (July), 894 (Aug.) 1916.

2. McKay, F. S.: Present Status of Investigation of Cause, and of Geographical Distribution, of Mottled Enamel, Including a Complete Bibliography on Mottled Enamel, J. D. Res., 10:561 (Oct.) 1930.

in given families, other families immediately adjacent being unaffected.

Because of such extreme examples of localization, together with the evidence supplied by afflicted districts in general, the conclusion became inescapable, through a process of elimination, that the cause was to be found in the water used for household purposes.

On the basis of that assumption, analyses in the usual form were made from samples of water collected from various endemic districts, none of which furnished indications of what the responsible element might be. One or two possible conjectures might be made; either these analyses failed of receiving a proper chemical interpretation or there was some ingredient in the water that the usual or ordinary methods of analysis failed to reveal.

It seems opportune at this point, in view of the difficulties that have been encountered in trying to relate the composition of these waters to the production of this enamel lesion, to point out the general lack of knowledge in relation to the whole subject of the process of calcification of the enamel; what ingredients are necessary; in what form they are presented to the elaborating organ; what substances may retard or interfere with the calcification process, and what the enamel really is after it has been completed in its calcification.

Concerned as we are with this chief dental tissue, for such it is as regards the beginning of decay, our position in this respect is almost indefensible, i. e., our lack of knowledge regarding it, and an appraisal of its essential composition by the mineralogist is imperative before we can with intelligence adopt measures for its protection.

It was conjectured early in the investigation that the lesion might be due to the "lack of something" in the water, the "something" being often construed to mean calcium.

Such a conjecture has never seemed tenable for the reason that calcium, as borne by water, is in inorganic form, and is hence unavailable for such metabolism as that involved in enamel calcification, and, further, that water is not to be considered in any important way, if at all, as a contributor of mineral elements to the general economy.

The contributions to the histology of mottled enamel by Black and later by Williams[3] definitely show the damage to the structure to consist in a profound alteration or distortion of the enamel rods in their general dimensions and characteristics, and a partial or even total absence of the cementing substance in certain areas of the enamel.

Williams shows that mottled enamel under the microscope is identical in appearance with a decalcified enamel. This has led me to suspect the presence in these waters of some decalcifying agent.

At any rate, it became evident that these waters carry some ingredient that is capable of profoundly interfering with the normal process of enamel calcification, either, it is assumed, through decalcification or because of toxicity.

Here, then, was an impasse, beyond which the investigation could not proceed until a further and more refined chemical determination of the waters became available.

The first break in this impasse was the announcement through private correspondence with Mr. H. V. Churchill, chief chemist of the Aluminum Company of America, in January, 1931, that his

3. Williams, J. L.: Mottled Enamel and Other Studies of Normal and Pathological Conditions of This Tissue, J. D. Res., 5:117-195 (Sept.) 1923.

studies of artesian water in a certain community in a southern state, which I will designate as X, had revealed the presence of fluorin, occurring probably as calcium fluorid, a constituent of water that had hitherto received scant attention, and one which the usual chemical analysis fails to reveal. In Churchill's work, its presence was detected by the spectroscope.

The water from which this determination was made was derived from artesian wells which had supplied the community for a period of about twenty years. Furthermore, this community, about three years previously, had been made the subject of a careful dental survey by Kempf and me, at the instance of the United States Public Health Service, and was thereby determined to be an endemic center in which mottled enamel occurred in 100 per cent of the native population. Its occurrence was found to be positively and definitely associated with the use of this artesian water.[4]

Other points, notably two, in Churchill's findings stood in peculiarly intimate relation with our previous knowledge of districts in which mottled enamel was endemic.

One of these called attention to the only known deposit of cryolite in the United States, on Pike's Peak in Colorado, cryolite being a double fluorid of sodium and aluminum. The waters draining from this water shed have been shown in previous publications of mine to be in definite and intimate association with mottled enamel in the various towns grouped around it.

The other point brings the information that "fluorids are very often found in the vicinity of volcanic activity, and in those localities where hot or warm springs are encountered." The significance of this statement becomes apparent if we recall the various localities described in our previously published articles, where mottling was endemic, and which derived their domestic water supply from warm springs.

To enable him to carry on additional determinations regarding the fluorin content of the waters of other centers where this condition was endemic, arrangements were made to supply Churchill with samples of water from the following places: Britton, S. D. (artesian); Oakley, Ida. (warm spring); Lidgerwood, N. D. (artesian), and Colorado Springs, Colo. (Pike's Peak).

The results of his determinations as announced through correspondence under date of March 5, 1931, are given in the accompanying tabulation, the fluorin being given in parts per million.

	Fluorin Parts per Million
Britton, S. D. (Hardina well* at Kidder, S. D.)	12.0
Oakley, Ida.	6.0
Lidgerwood, N. D. (Riba well)	11.0
Colorado Springs, Colo.	2.0
Artesian well at X (previously determined by Churchill)	13.7

*A description of the Hardina family is given in: McKay, F. S., "Progress of Year in Investigation of Mottled Enamel, with Special Reference to Association with Artesian Water, J.N.D.A., 5:721-750 (July) 1918.

In the article describing the examination of X,[5] attention was called to a neighboring community only 4 miles distant which was totally immune to mottled enamel, and to the water supply furnished to this town. It will also be noted in the same article that, on account of the enamel defect, X abandoned its artesian

4. Kempf, G. A., and McKay, F. S.: Mottled Enamel in a Segregated Population, U. S. Pub. Health Rep., 45:2923-2940 (Nov. 28), 1930; Reprint No. 1428.

5. Footnote 4, first reference.

supply and made connection with the source from which the immune town was supplied. Churchill announces that this water is free from fluorin.

In the laboratory treatment of these waters, they were evaporated to dryness, and when the residue was acidulated with sulphuric acid, hydrofluoric acid was evolved which acted characteristically on glass, i. e., etched it.

This fact brings up an interesting and possibly significant speculation. Following Williams' description of this lesion, referred to above, as being identical in microscopic appearance with a decalcified enamel, it has been difficult, for me at least, to put aside the idea that these waters were charged with a potential, persistent acidity capable of exerting a decalcifying action on the forming enamel.

Whether such a conjecture lies within the range of physiologic possibility, I do not know, but the demonstrated acidity shown by Churchill contributes to the tenacity of the conjecture.

Churchill further affirms that "the acidity of the water may be very important since in the presence of almost any acid some hydrofluoric acid might be evolved." In analyses of the waters of several endemic districts made during this investigation, it had been noted that the content of various acid ions stood in relatively high proportion. There is more that intimately relates the fluorin findings in these waters with the main problem, as the amount of fluorin present stands in more than a casual relation to the intensity or destructive character of the enamel lesion.

Of further collateral interest and value are Churchill's studies of twenty-six other communities (as published), including some of the principal cities of the United States; which showed that in no one of these was there a fluorin content of more than 1 part per million. Churchill states further that traces at least of fluorids are to be expected west of the Appalachians and that in no case were fluorids found in waters east of the Appalachians.

These facts peculiarly corroborate the actual findings during this investigation. Only one affected district is known to occur east of the Appalachians, namely, Franklin and the vicinity, in Virginia, and this an artesian district.[6]

It has been amply demonstrated that mottled enamel is distinctly limited in its occurrence in this country to the western region.

In the absence of any previous consideration of this subject, a range from 1.0 to 13.7 parts per million in fluorin would seem to indicate a narrow margin between total immunity and a severe manifestation of this lesion, and a still more striking conjecture is that, with immunity at 1.0 part per million, there should be a typical occurrence at 2.0 parts per million, as in one known community in the West. If so slight a range is sufficient, this agent is potent indeed in its disturbing effect.

It has been recognized by various writers that fluorin in the diet has had an influence on bone structure, and there are various references in the literature of biologic experimentation to indicate that disarrangement of tooth structure was brought about through the same agent. This will be referred to later in this paper.

Churchill is careful to point out that, concerning his findings, "it is well to emphasize the fact that no precise corre-

6. McKay, F. S.: Mottled Enamel; Further Consideration of Endemic Artesian District in Virginia, Together with Data Relative to the Brava People, Cape Verde Islands, J.N.D.A., 6:363-370 (April) 1919.

lation between the fluorine content of these waters and the mottled enamel has been established." He adds: "All that is shown is the presence of an hitherto unsuspected common constituent of the waters from endemic areas."

It is a fact that Churchill's work has more intimately and conclusively connected the water with this lesion than ever before, and supplied, for the first time, a definite approach to the solution of a problem that has been at the same time both baffling and mysterious.

This important announcement of the occurrence of fluorin in waters associated with mottled enamel was made by Churchill in a talk before the Section on Water, Sewage and Sanitation Chemistry of the American Chemical Society at Indianapolis, March 31, 1931, and in an item under "News," *Journal of Industrial and Engineering Chemistry,* April 10, 1931.[7]

May 18, 1931, Churchill presented his findings before the Pittsburgh Section of the International Association for Dental Research.

It is an amazing and well-known fact that, in research and in scientific investigation, important discoveries have often come as by-products of other, apparently unrelated problems. Churchill's work is another one of these instances.

His approach to our problem was that of the metallurgic chemist in the laboratories of a great corporation seeking to determine whether the use of aluminum utensils in cooking could be held responsible for certain deleterious effects that have been attributed to them. Not the slightest relationship was at that time recognized between that determination and mottled enamel.

The dental examination made just previously at *X* had drawn the attention of the parent company to the water there, *X* being the source of the aluminum-bearing ores. The laboratory findings showed the aluminum content to be low, but reported appreciable amounts of fluorin. The circumstance of finding so unusual a constituent as fluorin in a domestic water supply caused Churchill to twice reject the findings and repeat the analysis. The third time the certain presence of fluorin was accepted.

Acknowledgment is made of Churchill's scientific attitude in relating his findings with this problem in dentistry and in affording us the opportunity of cooperating with him in further study.

The circumstances under which this discovery was made have been commented on in a recent newspaper article referring to the awarding of the Nobel Prize, as follows:

> Fifty years ago the chemist or the physicist of high standing was looked on askance if he forsook the cloistered atmosphere of the university laboratory for a post with a manufacturing company. Today it is recognized that research is research, no matter where it is done. University professors find the scientific air of a corporation laboratory no different from that of one in a university. As a result, some of the finest work done in physics and in chemistry must be credited to the research staffs of our industrial organizations.

As a principle relating to the public health, it would seem that the presence, in a given state, of communities to which this defect of the enamel is endemic, laid an obligation on the resources of that state to determine its cause and find means of its prevention. The acceptance of such an obligation has been conspicuously lacking in the several states that have been

7. The complete paper covering his work was published in the September, 1931, issue of the Journal of Industrial and Engineering Chemistry, and reproduced in the issue of the same month of the Journal of the American Water Works Association.

shown to include such endemic districts.

The existence of afflicted communities in Arizona has been pointed out in certain published articles during the past several years and it is her distinction to have been the first state to devote exhaustive study to this problem in a state university.

It is not overlooked that work on this problem was done at West Texas State Teachers' College by Pierlé[8] some few years ago and it is also true that a survey of several afflicted districts in Kansas was made by R. W. Kehr, assistant engineer, state board of health, Lawrence, Kan.[9]

The results of the study in Arizona were published by the University of Arizona, College of Agriculture, under the title, "The Cause of Mottled Enamel, A Defect of Human Teeth," by Margaret Cammack Smith, and Edith M. Lantz, department of nutrition, and H. V. Smith, department of agricultural chemistry, Tucson, Ariz.[10]

A preliminary statement of their findings in this study was published under the heading "The Cause of Mottled Enamel,"[11] and dated April 27, 1931.

The basic feature of their work was an examination of a small community, St. David, situated 63 miles southeast of Tucson. This examination, in which they were assisted by Dr. A. E. Bard, of Tucson, included the entire school population and subsequently almost every home in the town was visited in order to observe and record the history of those beyond school age.

In all, the report covers about 250 persons whose histories are recorded in tabular form, and shows that every person who was born and reared in the vicinity of St. David, or who came there during the early years, has mottled enamel on every permanent tooth; in other words, an affliction of 100 per cent of the native population. On the other hand, those who were born elsewhere and later became residents of this town, after the permanent teeth had been formed, were free from this defect.

Conditions precisely parallel to this have been emphasized in previous descriptions of other communities in which this condition is endemic. The significance of this fact becomes apparent only when it has been related to the main facts of enamel histology as we know it.

This fact is also illuminating with regard to the current discussions as to the expectancy of producing posteruptive alterations in the enamel structure through dietary changes.

It has become established through this investigation of mottled enamel that some ingredient of water is capable of profoundly altering the intrinsic structure of enamel during its calcification period, and that this ingredient invariably so acts. To a reasonable degree these researches that I am describing have satisfied us that this responsible ingredient is fluorin.

It has been observed in every affected community that such teeth as have been developed elsewhere in persons who later became residents of this community undergo no damage from its water. Why? Because on completion of its calcification and in eruption, the enamel becomes detached from its vital base, and henceforth there are no means through which its component cell structure can be altered or damaged except from external influences.

8. Pierlé, C. A.: Production of Mottling and Brown Stain, J.A.D.A., 13:999-1012 (July) 1926.

9. Kehr, R. W.: J. A. Water Works Ass'n, February, 1931.

10. Smith, Margaret C., et al.: Tech. Bull. 32, U. Ariz. Agr. Coll., June 10, 1931.

11. Smith, Margaret C., et al.: Science, 74 (Sept. 4) 1931.

When so potent a substance as fluorin, if this it be, which is capable of producing such damage during the formative period, is incapable of exercising a similar influence on the enamel after eruption, by what process of reasoning do we assume or expect that the ingestion of other substances can have different results?

The examination of St. David and the recording of the results was a laudable and careful piece of work, the conclusions of the examiners being that there could be no other conceivable source than the water.

For the past forty-two years, St. David has drawn its water supply from artesian wells, but it is true that mottled enamel was existent there before the advent of artesian water. As recorded numerously during this investigation, mottled enamel has been found associated with waters from almost every conceivable source, but so often with artesian or deep wells that a natural suspicion has grown up against such waters. A table of analyses of the waters from various wells both here and elsewhere, giving the usual constituents as in the ordinary "stock" analysis, fails to point to any conclusions, and the authors concluded that a more refined analysis was necessary.

The investigators in their report confirm my expressed opinion that mottled enamel is not observed to occur "naturally" in other animals of an endemic district. None were observed at St. David with its 100 per cent affliction of the human teeth.

From this point, the work of these investigators was taken into the laboratory and animal feeding experiments were begun. Due deference was given to the prevailing opinion that mottled enamel might be an expression of a dietary deficiency, as commonly understood, by feeding the laboratory animals diets that were either deficient in tooth-forming elements or diets in which these elements were in disproportion in amount, and others which were lacking in vitamin D, the calcifying regulator.

The results were pronounced abnormalities and distortions in shape and calcification similar to those reported by various other investigators, but which could not be considered the characteristic mottling of enamel of human teeth.

To further follow the possibility that dietary deficiency might be a ruling factor in the production of the actual conditions at St. David, a three-weeks' observation was made of actual rations of nineteen children.

While the details of this observation will be reserved for a later report, it was evident that these rations were not sufficiently deficient in either calcium or phosphorus to account for the serious interference with calcification of mottled enamel.

These investigators have further undertaken to test the possibility of preventing the mottling of the teeth of St. David children through a feeding experiment with thirty-five children in which possible dietary deficiencies have been corrected. This experiment began in October, 1930. and naturally it is too early as yet to observe the results.

These authors are emphatic in pointing out that the disruptions of tooth form and structure reported by other investigators through lowering the calcium content of diets fed to experimental animals are not to be confused with the typical mottled enamel of human teeth.

The use of the rat for a laboratory experiment of this sort is open to the serious objection that the growth period of the teeth is extremely short when compared with that of human teeth, an objection which was recognized by Smith and

her co-workers. A week in a rat's life is stated to be about equal to a year in the life cycle of a human being.

In such of these rats as were given St. David water in conjunction with an adequate ration, no damage from the water was discernible, but, without exception, to quote from her report, "When the diet was sufficiently deficient in itself to produce observable changes in the incisors, the animals receiving St. David drinking water gave evidence of this interference at an earlier age."

These authors conclude that the St. David water "contains something the destructive action of which is more pronounced when the tooth is poorly nourished."

Calling to mind again the short developmental period of the rat's teeth, I offer the interpretation that this water in its normal concentration (unevaporated), as fed to these rats, was not sufficiently potent in its destructive effect through this short growth period, but required the "booster" action of an inadequate diet.

In the belief that "there was some toxic material in the water rather than that the water was lacking in some element necessary for the normal development of enamel," attention was directed to "the concentration of the material supposedly present in the St. David water."

This experiment had three phases, all animals receiving an adequate basal diet. Certain of these were given water that had been "concentrated by evaporation to one-tenth of its original volume"; others of the same litter received only distilled water, and, in the third group, "the water residue was incorporated directly into the rations."

The investigators state that the enamel of the control animals which had received distilled water developed normally. Those that received the concentrated St. David water and the third group, in whose ration the water residue had been directly incorporated, both developed enamel lesions that were construed to be "similar if not identical to the mottling seen in human teeth."

The rapidity with which this interference occurred substantiates my recorded observations to the effect that the water acts with remarkable promptness on forming enamel.

Additional substantiation of my own expressed opinion is afforded by these experiments, it seeming evident that drinking water alone was not wholly accountable, but that the concentration of the water in cooking was equally important.

The observation that manganese is the source of the "brown stain" that often accompanies mottling of the enamel on certain surfaces of the teeth, was reported[12] as a matter of record. No statement was made to indicate that manganese was to be found in waters and none that the "brown stain" was attributed to the water. Up to the present time, there is nothing except the manganese theory to indicate that we have the slightest knowledge as to the nature or derivation of this pigment.

The *Arizona Bulletin* goes on to state that no manganese was found in the St. David water and that the addition of manganese to the diet of the rats produced no effect.

Various references in the literature of biologic chemistry (McCollum and coworkers; Schultz and Lamb; Taylor; and McClure and Mitchell) are alluded to in the *Bulletin* bearing on the action of fluorin salts in the ration on the form and structure of the teeth of experimental animals. The descriptions of the lesion thus produced are generalized, containing

12. McKay, F. S.: Chemical Determination of Discoloration Known as Brown Stain, D. Cosmos, 69:736-738 (July) 1927.

no direct reference to the production of mottled enamel. Such references could do no more than to point the way to further experiments.

Smith and her collaborators presumably acted on these suggestions, and, in the work following, varying small percentages of sodium fluorid were incorporated in the ration fed to rats. Results were immediately forthcoming in producing enamel defects that were reported as being so "strikingly similar" to those produced by the residue from the St. David water "that no one could fail to associate the two."

The final corroborative step was the detection of fluorin in the waters from St. David through qualitative analysis. The *Bulletin* refers to the work of Gautier, a French chemist, who found varying amounts of fluorin in waters, so-called "mineral waters" containing larger amounts. The term "mineral" as applied to waters is almost meaningless, all water except distilled containing more or less "mineral" substances. The term "mineral water," then, as in ordinary use, probably implies water from an unusual source such as "mineral" springs, warm springs and deep wells.

The presence of fluorin in considerable amount in water from such sources is exactly what Churchill has shown in his work previously outlined in this paper. The unusual phase of the situation as referring to mottled enamel comes about in the utilization of such waters by communities and families for their domestic supply. In seven of these wells that are definitely associated with mottled enamel, the fluorin content varied from 3.8 to 7.2 mg. per liter of water, which translated to parts per million to correspond with Churchill's figures are, respectively, from 3.8 to 7.2.

Waters from other endemic districts in Arizona mentioned in the report show about the same variations in fluorin content in most cases, possibly a little less than at St. David, but waters not associated with mottled enamel show less than 1 mg. per liter, or 1.0 part per million.

An interesting case history as cited by the authors in their report has to do with two children in a certain family living 7 miles out of St. David. These two children were the only persons born and reared in this district who had escaped mottling of the enamel.

The water on this homestead was from an artesian well 775 feet deep and contained less than 1 mg. of fluorin per liter; whereas, the other wells in the district were only about 350 feet deep and contained, as before cited, from 3.8 to 7.2 mg. per liter; which would indicate that the properties of the well as regards fluorin depend on the stratum from which the water is derived.

This calls to mind studies made in South Dakota some years ago in which it was found that the waters associated with mottled enamel were drawn from artesian wells penetrating the Dakota sandstone layer.[13] Various other districts throughout South Dakota use artesian water almost exclusively, with no reports, of which I am aware, of mottled enamel. The inference is that the wells in such districts derive their water from other layers.

The possibilities of such variations in waters in reference to fluorin cannot too strongly be brought to the attention of municipalities in which this enamel lesion already exists, and to others which may in the future be contemplating an artesian supply.

13. McKay, F. S.: Progress of Year in Investigation of Mottled Enamel with Special Reference to Association with Artesian Water, J.N.D.A., 5:721-750 (July) 1918.

Another illustration of the same possibility is given in the *Arizona Bulletin*. On the Pima Indian Reservation at Sacaton, with its 100 per cent affliction in association with shallow wells,[14] containing 3.9 mg. of fluorin per liter, absence of mottled enamel is found in association with the Government deep well, which gives 0.5 mg. of fluorin per liter.

Smith and her co-workers offer the speculation that the degree of concentration of fluorin may stand in relation to the severity of the enamel damage. From my knowledge, this relationship seems to be indicated in the figures submitted by Churchill.

A more interesting phase of the problem is strongly set forth in the work of the Arizona group in their determination that the richness of the ration in calcium and phosphorus has to do with the speed at which the enamel defect progresses and with the intensity of its final manifestation as well.

It has long been known that of children living in the same endemic community, some would exhibit the lesion in a far greater intensity than would others. The dosage of the damaging substance being probably about the same, there was a hidden physiologic condition that must account for the difference.

The practical application of dietary considerations to this problem by way of minimizing its deplorable features is worthy of study and experimentation. I find it difficult to conceive that the addition to the ration of any rational amount of calcium, phosphorus or vitimin D, in any combination, could completely nullify the action of the responsible element in the water, fluorin it seems to be, in any community that is definitely and pronouncedly affected.

The most direct approach to nullification, short of a substitution of the water supply, is treatment of the water to change the soluble fluorids to an insoluble form, or other measures, whatever they may be, that will prevent their action on forming enamel.

In tests following the direct path from the suspected waters to the experimental animals in the laboratory, the biologic complement of Churchill's disclosures, Smith and her co-workers show a brilliant achievement in research, all the more remarkable for the reason that not being within our own profession, their attitude was without bias by prevailing dental opinion.

The profession of dentistry appropriates this work, conceived from the standpoint of the nutritional chemist, with gratitude as bringing a troublesome problem within hailing distance of a solution. These findings were reported at a meeting of the Pittsburgh Section of the International Society for Dental Research at the meeting previously referred to, May 18, 1931.

To stamp this work in Arizona with the essence of finality, there remains only to submit histologic evidence that the lesion which has been experimentally produced, is identical with mottling of the enamel as we know it. This is promised at the conclusion of the report.

Finally, appearing in *Science*,[15] is an announcement by Dr. Smith of the production of mottled enamel in dogs through the introduction of fluorin in the drinking water, after a six months' feeding experiment.

The change from the rodent type, as represented by the rat in the earlier ex-

14. McKay, F. S., and Black, G. V.: Investigation of Mottled Enamel, D. Cosmos, 58:477-484 (May), 627-644 (June), 781-792 (July), 894-904 (Aug.) 1916.

15. Smith, Margaret C.: Science, 74:1922 (Oct. 30) 1931.

periments, to the dog is logical because of the closer resemblance of the dog to the human being, in the length of the calcification period and in the presentation of temporary as well as permanent teeth, together with the added advantage of an amount of tooth material for observation greater than in the rat.

With the possibility of sectioning the skulls of dogs at various stages of enamel development, to observe the manner of attack of a toxic substance, the last obstacle to a complete understanding of the problem will have been removed.

2 East Fifty-Fourth Street.

AMALGAM—ITS PRACTICAL APPLICATION AS A FILLING MATERIAL AND SOME OF ITS PROPERTIES BROUGHT OUT BY RECENT RESEARCH WORK*

By JOHN T. HANKS, D.D.S., New York City

AMALGAM has occupied a unique place among the materials used in the realm of dentistry. Indeed, if its history was not so well authenticated, we might almost say that it was a product of the imagination.

It has had more "ups and downs," and more heat and anger generated over it than any of the controversial materials brought forward during dentistry's advance. The very name under which it was first introduced into this country, while high sounding and of a romantic quality, was enough to condemn it forever. "The Royal Mineral Succedaneum" expressed perfectly the quackery by which it was introduced, for of such caliber were its introducers, the Crawcours. Its early vogue reflected the spirit of the age when anything coming from abroad was welcomed without question in this country. Perhaps, its early success was due to the ease of its manipulation as the procedures of that day for filling teeth with gold must have been trying to both operator and patient. However, the fillings soon blackened or dropped out, and the charlatans departed between two days, leaving behind many sorrowing patients.

The succeeding "amalgam war" was to be expected after the manner of its introduction. Also, the early methods of manufacture and technic were not such as were calculated to produce a very desirable or dependable result.

When Flagg and others investigated this material, it was given a certain standing which was further improved by the investigations of G. V. Black and by the studies and research of Harper at the present time. As a matter of fact, the bad features of amalgam have been due to poor workmanship both in the production of the alloy and in the manipulation of the amalgam.

The early formulas for alloys were far from scientific, and the methods of cavity preparation and further manipulation were very faulty. Since the monumental investigation by Black of alloys and amalgams, the failures of amalgam fill-

*Read before the Section on Operative Dentistry at the Midwinter Clinic of the Chicago Dental Society, Jan. 19, 1932.

ings may be laid at the door of the dentist. The profession as a whole has not kept pace with the makers of dental alloys.

Faulty cavity preparation and careless technic in the manipulation of the amalgam, principally lack of proper mixing and packing, have given amalgam a bad name. If our foil fillings or gold inlays were handled with an equally faulty technic, we would be tempted to condemn gold as a filling material.

It is a curious fact that so many men seem to be more interested in the make of alloy than in mastering a definite technic. Many men do not follow out a reasonable procedure to get the best results. The best alloy and mercury ever made can be spoiled by careless handling. In amalgam procedure, we have a chain of steps to be carefully followed out in order to produce the most desirable results. These steps are simple, and an ordinarily skilful man should have no trouble in mastering each one successively; but he must perform each step carefully in order to assure a completed operation that will be a credit to him and the profession.

Recently, the workers in the Bureau of Standards have developed specifications and procedures whereby dental alloys can be tested and appraised. The findings have tended to revolutionize the manufacture of dental alloys, and the benefits on a whole have been very satisfactory. Some manufacturers have changed the directions for procedure so as to meet certain requirements of the specifications; for example, recommending shortening the time of amalgamation. This does not seem to be a wise move even though it produces an expanding amalgam.

Undertituration is known to produce qualities in the amalgam which are very undesirable. If it has been generally determined that three minutes should be allowed for proper trituration, some other method should be used in the process of manufacture to secure expansion, rather than imperfect amalgamation. Changes in manipulation change the performance of the amalgam.

It would seem, therefore, that a fairly definite technic should be worked out and then bring the formula and processing to meet the requirements of the specifications rather than to make vital changes in the technic.

I believe in amalgam as a tooth preserver, but I insist that a correct technic be exactly followed. The future holds much for the amalgam filling as its usefulness is beyond question, and with new methods of production and manipulation, which are sure to come, it will be recognized as one of our valuable aids; but as nothing can replace skill and conscientious work, it will be ever necessary to demand the best of each of us. In this way, with as great care used and as high standards set to attain as are now demanded in all other procedures followed by our profession, amalgam will come into its own place.

The time allotted will not suffice to go over a detailed amalgam technic at this time, but I should like to emphasize a few of the essentials in producing a satisfactory piece of work.

To begin with, we must have good materials. A carefully compounded and processed alloy is essential. Freedom from all foreign materials is imperative. Then, a mercury of the greatest purity must be used. The compounding of the alloy and mercury must receive the greatest care as to the proportions and the cleanliness of mortar and pestle. The time and manner of trituration must be followed out on a definite plan and carefully controlled.

Insertion and packing must proceed in an orderly manner. The employment of a matrix in all three-walled cavities is ab-

solutely necessary to confine and condense the filling properly.

Carving to as nearly anatomic form as possible and the development of a contact point are essential to the future usefulness and health of the tooth in question; and, finally, polishing after at least twenty-four hours have elapsed is the procedure that brings joy to the careful operator in observing the finished result of his careful handiwork.

LINING AND STERILIZATION OF CAVITIES

All cavities except very small ones should be lined.

In those of moderate size, a lining of chloroform-resin or copal-resin will suffice. Deeper cavities should have a floor of cement.

Sterilization of the cavity may be obtained in several acceptable ways. The following procedures, which were originated by Prof. Hermann Prinz of the University of Pennsylvania have been found to give very satisfactory results.

1. Wipe the completely prepared cavity with a mixture of one part chloroform and three parts alcohol and dehydrate with warm air until the cavity has a chalklike appearance.
2. Saturate the cavity with thymol solution on cotton and evaporate to dryness.
3. Coat the cavity with copal-resin varnish and apply warm air until dry.
4. Plane the margins of the cavity with a sharp chisel.

(Thymol solution is made as follows: One ounce of thymol dissolved in alcohol sufficient to make 2 ounces. Keep in a well-stoppered brown bottle.)

Silver nitrate may be used as a sterilization medium in deep cavities. Where it is desired to place it on a specific area, we may employ the following procedure:

Make a concentrated silver nitrate solution by crushing a few crystals on a glass slab adding a few drops of 1 per cent solution of nitric acid. To place the silver solution conveniently upon a specific area mix it into a paste with a small quantity of alloy. This paste may be easily carried to the selected spot, where it can be burnished with an amalgam instrument. Reduce the silver solution by applying sodium hydroxid-formalin solution. (This solution consists of nine parts of a 1 per cent sodium hydroxid solution and one part of formaldehyd solution [40 per cent].)

SLICE EXTENSION LAP PREPARATIONS AND RESTORATIONS

By ELDON L. KNOX, D.D.S., Dallas, Texas

WHEN the late G. V. Black gave to the dental profession his classification of cavities and seven general principles or order of procedure in cavity preparations, he did so with the thought that these cavities would be filled with gold foil or amalgam. The dental profession as a whole have accepted Dr. Black's teachings as a standard, and little attempt to deviate from his teachings has been made. Little thought was given to preparation of teeth to receive cast inlays, as the gold inlay was then in its developmental stages; but if Dr. Black had lived a few years longer, he would probably have given us some valuable information on cavity preparation to receive cast in-

*Read before the Section on Operative Dentistry of the Midwinter Clinic of the Chicago Dental Society, Jan. 21, 1932.

lays. Conditions have changed, and we have improved our technic through failures and progress. Many things, too numerous to mention, have entered into the advancement of operative procedures. Through past experience, we have come to see many of our mistakes, and much has been done to correct them.

There has been a great deal of research work done, in the past few years, on the casting technic, by various men in our profession, many introducing new products such as waxes, investments, casting machines, burning out ovens, and golds, things that could be commercialized. Many lay ridiculous claims to their products, stating that they were "sure cures" and "fool proof" and would give 100 per cent castings. These products were bought freely and many thousands of dollars were spent by the profession in seeking the correction of their failures, and the perfection of the casting process, which is now in sight. Little thought had been given to the development of cavity preparation for the cast inlay, which could be used to correct the failures that we were experiencing.

I have experienced many failures in reconstruction work, most of which, I believe, were due to the type of cavity preparation that I was using, plus the casting technic. Having had training under Dr. Black, I felt a delicacy in deviating from his teachings, and after I had adopted this change in cavity preparation, I was somewhat reticent about letting it be known. But the more I used it, the more enthusiastic I became. As with a great majority of dentists, my difficulty lay in failure of the cast inlay to fit at the gingival margin, where most compound inlays are defective.

Figure 1 shows the restoration of the lower right first and second molars, the first molar being restored with an inlay with the slice extension lap cavity preparation and restoration. The second molar was restored by the usual type of cavity preparation and restoration. When the gingival fitting of the two inlays is noted, quite a discrepancy will be seen to exist between the inlay and gingival wall of the second molar. The first molar shows just a line of demarcation and quite a nice fitting.

Recently, I sent out fifty questionnaires to specialists in oral surgery and roentgenology throughout the United States, geographically located to cover all sections of the country, to get an impartial idea as to where the failures and defects in compound inlays occur. The questions were as follows:

1. What do you find to be the weakest point of the average inlay?
2. What surface of the cemented inlay do you find most frequently defective?
3. On what surface of the cavity restored by inlays do you most frequently find the recurrence of decay, if any?

Thirty-eight replies were received. The answer to all three questions, directly or indirectly, was the same: The gingival wall.

Why is the gingival wall such a vulnerable surface in the average compound restoration? First, and most important, in the box type cavity preparation with the flat floor and butt joint or shoulder, there is the difficulty in seating and in finishing the restoration, leaving a discrepancy between the gingival wall and the inlay, and rendering this surface more susceptible to recurrence of decay.

The requirements of cavities to be restored with cast inlays differed considerably from those of cavities to be filled with gold foil or amalgam, details of which I shall endeavor to bring out clearly, in explaining the slice extension lap cavity preparation and restoration. Through

the lack of a better word or term, the word "slice" has been used to describe a similar type of cavity preparation. I believe that "slice extension lap" is more descriptive of this principle. "Slice," to cut off or cut through, leaving a smooth surface, means here an exaggerated beveling of the cavosurface angle; "extension"

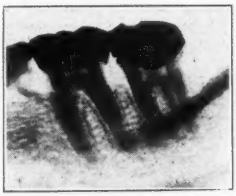

Fig. 1.—Restoration of lower right first and second molars. The first molar was restored by an inlay with the slice extension lap cavity preparation and restoration. The second molar was restored by the usual type of cavity preparation and restoration. When the gingival fitting of the two inlays is noted, quite a discrepancy will be seen to exist between the inlay and gingival wall of the second molar. The first molar shows just a line of demarkation and a quite nice fitting.

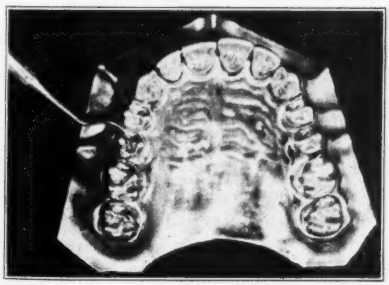

Fig. 2.—Cast of upper denture. The explorer points to the mesial surface of the upper molar, where decay has just made its appearance.

meaning extension for prevention, representing the outline form on the smooth surface of the preparation; "lap" meaning that part extended over, or that part of the inlay which overlaps, the cavosurface angle, or the beveled surface of the cavity.

The slice extension lap cavity preparation is indicated in all approximal and approximal occlusal cavities that are to be restored with the cast inlay. On teeth that are to be prepared for the full or partial crown, on molars showing occlusal and buccal decay, the two cavities are combined and made into one cavity, and restored with a single casting.

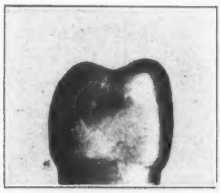

Fig. 3.—Mesial view of molar pointed out in Figure 2, showing area of beginning decay. This stage of decay is usually revealed by the roentgen rays.

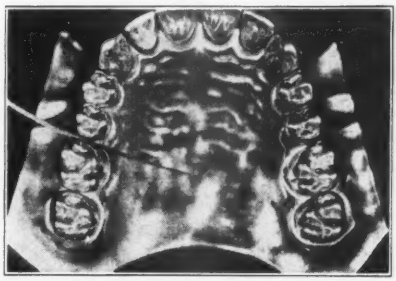

Fig. 4.—Cast of upper denture showing use of metal safe side strip by which access is gained, with sawing motion, through area of contact. The cutting surface is toward the tooth surface to be prepared, and cutting is continued through the contact area until there is no resistance.

In using the slice extension lap cavity preparation and restoration, many difficulties and failures can be overcome. The thing most important in cavity prepara-

tion, to my mind, is conservation of tooth structure and extension for prevention. One rarely reads literature on operative dentistry but that the author lays special stress on conservation of tooth structure in cavity preparation, but fails to explain how this can be accomplished. As time will not permit me to cover all types of preparation in this paper, I shall cover it in a general way only. I shall describe the preparation of an approximal mesioclusal (Class 2) cavity in an upper first molar, in contact with the second bicuspid, caries having penetrated through the enamel, but the marginal ridge being uninvolved, the type of caries which is found in the early stages of decay. The first thought in making the slice should be to protect the approximating surface of the adjoining tooth. If the slightest etching of the enamel occurs on an approximal surface, decay will begin.

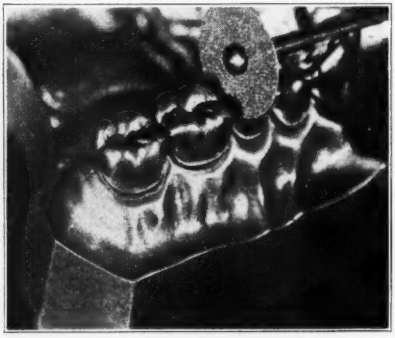

Fig. 5.—Use of metal disk after free access has been gained through contact surface.

Access is gained through the contact by using a metal safe side strip with a sawing motion, the cutting surface toward the tooth surface to be prepared, cutting its way through the contact until there is no resistance. It is safe then to make further progress by use of the safe side lightning disks. One should be very cautious, in the use of the metal disk, owing to the danger of its wedging and hanging, then slipping and cutting the investing tissues, cheeks or lips. Its use is contraindicated, unless free access through the contact has been accomplished, which can be done by the above described method.

This one step in preparation is very important, and failure to carry it out correctly will defeat one's purpose. We should never attempt to make a slice with a vulcanite disk, as they are dangerous to handle and do not adapt themselves to the tooth surface. There is no such thing as a safe sided Jo Dandee disk, as they all cut on both sides, one side more than the other. Frankly, every time I have used one, I have done more harm than good. Figure 6 shows what is said to be the correct and incorrect ways of using the Jo Dandee disk. To my mind, there is no correct way to use this disk in making a slice where two teeth are adjoining as described above. The use of a Jo Dandee disk in making the slice is contraindicated. It has no place in my hands in a shoulderless preparation, in contact with a healthy tooth surface.

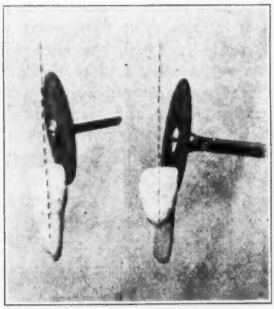

Fig. 6.—So-called correct and incorrect methods of using the Jo Dandee disk, employment of which is contraindicated in all slice preparations where two teeth are adjoining.

The marginal ridge is broken down with a small chisel. It may be necessary to cut through the ridge with a round or inverted cone bur No. 0 or No. 1 before the chisel can be used. After breaking through the marginal ridge and unsupported enamel, the cavity is extended buccally, lingually and gingivally for the extent of the decay.

The decay is removed with round burs and spoon excavators; the dentin sterilized with ammoniated silver nitrate, reduced with formalin or oil of cloves and coated with cavity varnish. The undercuts or axial wall depression is filled with copper cement, and the walls squared with fissure burs and stones. With a small mounted knife-edged stone, the central groove is cut through to the dentinoenamel junction. To complete the preparation of the pulpal wall, a No. 1, 2, 3 or 4 inverted cone bur, or a larger one, as the case may require, is used for extension and retention, the extension of the entire groove being followed out with cross-cut fissure burs and the cavosurface angle finished with mounted fissure stones. The final finish of the slice is made with a very fine, wet or dry, paper disk. This slice should be very definite and register clearly in the impression material. A trial impression should be made to see that the slice is definite. I wish to emphasize that all slices and grooves should be as nearly parallel with the long axis of the tooth as possible, slightly diverging toward the center of the tooth, at the incisal or occlusal surface. A slice made in this manner permits the withdrawal of the impression material without resistance and distortion, and at the same time adds to the retention of the finished restoration. Retention grooves or axial grooves or approximal steps should be square in that the lingual, buccal and axial walls should form walls at right angles, if possible. Many times this is impossible because of the extensive destruction of tooth structure by caries.

There is no set rule that answers all requirements as to the direction or posi-

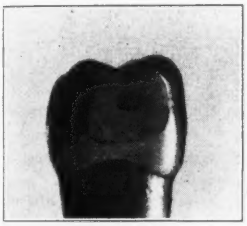

Fig. 7.—Completed slice. The entire surface of liability has been sliced away. This surface will be entirely covered with gold in the finished restoration.

Fig. 8.—Approximal step and finished preparation. The approximal step has not been extended buccally, lingually, gingivally and pulpally any farther than the area of decay. Conservation of tooth structure is evident.

Fig. 9.—Typical Black box cavity of tooth and type of decay shown in Figure 8 plus slice on approximal surface.

tion of a groove. Each tooth to be prepared offers its own individual problem. Much depends on the position of the tooth, the extent of decay, if any, the amount of retention required, esthetics, etc.

The slice extension lap cavity preparation and restoration have been made possible by the use of the hard alloyed golds. If it were not for these golds, we should have to continue the use of the Black box type cavity preparation.

To review the preparation of this particular type of cavity and visualize each step:

In the upper first molar with mesial approximal decay, there is the characteristic whitish area, the slightly stained area of beginning decay, just below the contact point, and about 2 mm. above the free margin of the gums and, within the embrasures, decay which has penetrated the dentin, a few of the enamel rods having fallen away forming the cavity. The

Fig. 10.—Left: Filling of dentinal tubules with micro-organisms. The dentino-enamel junction is at the top of the illustration. The organisms have entered the tubules and by continued growth and multiplication have filled and enlarged them very evenly, having grown single file into all of the smaller side branches. Only a few slight local swellings of the tubules are seen. The left of the illustration is near the margin of invasion, where new tubules are as yet but partially filled. Great differences are found in different specimens in the number of smaller side branches. Some have very few after passing a little way from the dentino-enamel junction. Right: Filling of dentinal tubules with micro-organisms, in which, as compared with the figure on the left, the opposite extreme as to side branches and irregular swellings of the tubules is shown. This figure represents perhaps a maximum of irregular swellings of tubules, and absence of side branches. This section is taken from deeper in the tooth close on the deeper margin of invasion. The two specimens were from different teeth and have been selected as representing the extremes of smoothness of the filling and enlargement of the tubules, as seen in the figure on the right. All gradations between these two illustrations are found. (Black.)

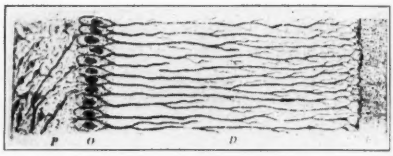

Fig. 11.—Diagram illustrating sensation without nerves in dentin. *E*, enamel; *D*, dentin; *O*, layer of odontoblasts; *P*, pulp of tooth with nerve endings in physiologic connection with odontoblasts. The fibrils of the dentin are prolongations of the odontoblasts. Any injury to them is an injury to a portion of the odontoblasts and is transmitted by the nerves to the brain. (Black.)

Fig. 12.—Wax bite in tooth with proper embrasure and tooth form carving and registration of contact surface of adjoining tooth. This contact surface should not be altered by adding wax, and it will not be necessary to add solder to the contact surface of the finished inlay, since, in the finished product, the contact will be found to be correct.

mesial surface which is liable to decay is sliced off. The decayed area is cut out and squared for the extent of the decay. The step should not be extended farther buccally, lingually, pulpally or gingivally than the extent of the decay, unless for retention purposes or to give bulk to the casting, to meet the requirements of stress of the opposing teeth during mastication. The occlusal step is made to connect with the mesial into a Class 2 cavity, the beveling of the enamel rods being exaggerated at the cavosurface angle. The flanges or lap of the inlay covers the entire sliced surface; which simplifies and conserves tooth structure and thoroughly covers and protects the susceptible surface from decay.

Fig. 13.—Mesial surface of inlay. The surface making contact with the adjoining tooth has been reproduced. This surface is considerably exaggerated, but shows plainly the contact surface.

Some of the advantages of the slice extension lap over the typical Black box type preparations are as follows:

1. The slice extension lap, when used, conserves tooth structure in that it is not necessary to extend the approximal step farther than the decayed area, except when this is necessary for additional retention.

2. The slice extension lap does not weaken the tooth by extensive or excessive cutting of the tooth structure.

3. The slice extension lap leaves a solid wall of sound, healthy enamel which the inlay overlaps, all margins of the inlay being thus brought to and overlapping the enamel margin. This places the cement between the lap of the inlay and the enamel margin, the cement being the weakest part of the inlay in that deterioration of the cement may take place after a time. Therefore, we should keep in mind that the margins should not show cement lines, especially on the susceptible surfaces. The slice extension lap brings the cement margins out to the immune surfaces, with a solid wall of healthy enamel as a base. Should deterioration of the cement occur, decay would have to take place on the enamel, a surface that is practically immune to decay.

Fig. 14.—Roentgenograms taken in determining the fit of two extensive inlays, prior to seating. Below, the discrepancy or overhang on the mesial surface of the first molar is evident. Above, the corrected condition and the inlays ready for seating are shown. The bite of the second bicuspid is taken after the seating of the first bicuspid and first molar; which enables the operator to obtain the correct occlusion and tooth form, registering the contacts of the two adjoining teeth in the wax. In securing contact with this method, the two adjoining teeth are not spread or pushed out of their normal position, but this allows correct cuspation in centric occlusion.

In the box type, a typical Black preparation, where the gingival wall is definite.

like a shoulder, this gingival wall and the inlay contact with a butt joint, and, in the hands of at least 90 per cent of the dentists, there would be a line of cement showing between the inlay and gingival wall, which, in a short time, would deteriorate and wash out, decay occurring; which would give a direct avenue into the dentin and to the pulp. The gingival wall is the most vulnerable surface in all cavity preparation and restoration, and the gingival wall is the most difficult to fit with an inlay, to say nothing of finishing the margin.

4. The slice extension lap cuts away that part of the enamel of the tooth that is most susceptible to decay without involving the dentin beneath and extends its margin out to immune areas. Teeth prepared and restored in this manner are rarely ever sensitive to thermal change, pulp involvement is rare and decay at the gingival margin seldom, if ever, occurs.

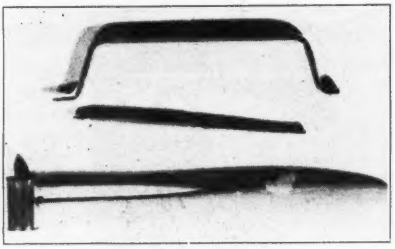

Fig. 15.—Instruments used in seating inlay, consisting of straight seater for anterior part of mouth and angle seater for posterior. The ends of the seaters are constructed of soft copper points and the face of the mallet is leather, which cushions the blow in the vibratory tapping which waves the surplus cement out. These instruments are known as the Prime seaters and mallet.

5. The slice extension lap cuts away that part of the bell of the tooth which hinders the withdrawal of the impression without distortion.

6. The slice extension lap simplifies cavity preparation, making the operation less complicated for the operator and not so trying for the patient. Why try to do the almost impossible, with its complications and uncertainty, saying, "I was taught in dental college to make a butt joint cavity and inlay; and why should I change my methods?" believing that Dr. Black's was the last word in cavity preparation.

I have heard it said that cavity preparation depends on who fills the tooth first. In a way, I agree with this statement, especially when I have to reprepare a tooth that has been badly mistreated by one who disregards the need for cutting healthy tooth structure. Also, cavity preparation depends on the extent of the decay and the position of the tooth; but the principles of the slice extension lap, and all types of cavity preparation for cast inlays are always the same, in that

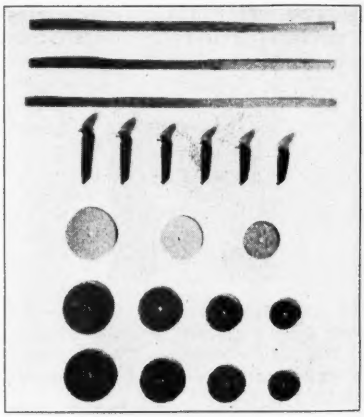

Fig. 16.—Top to bottom: Metal strips used for gaining access through contact area; mandrels for right angle, lengths ranging from three-eighths to one inch, especially adapted for use in small head right angle handpiece; metal safe side disks; wet or dry paper disks; heavy cutting disks.

the shoulder and butt joints are done away with by making lap joints.

We all agree that the time to find cavities and make restoration is in the early stages of decay, before the dentin has been penetrated to any great extent, and while the dental pulp is still in a healthy condition. Early decay is characterized by a whitish chalky area on the tooth, on susceptible surfaces and is due to the dissolution of the calcium salts of the intercementing substance that holds the enamel rods together. When this dissolution of the calcium salts takes place, this characteristic opaque area develops. As this dissolution extends, the enamel rods begin to fall away and the cavity begins to form. The decay extends laterally along the dentino-enamel junction, which forms its base. The decay progresses into the dentin toward the pulp, and, if permitted to progress without interference, will extend to and destroy the pulp; which ultimately causes the loss of the tooth. As soon as the enamel rods fall away, and the cavity begins to form, micro-organisms enter the dentinal tubules, which become literally filled with various kinds of infectious organisms that penetrate to the pulp through the dentinal tubules in advance of the decay. That these micro-organisms, or their toxins, get into the blood stream after they reach the pulp has been proved by many scientific researches.

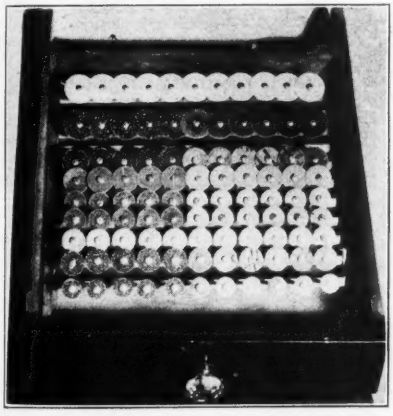

Fig. 17.—Drawer in cabinet especially designed to hold mounted mandrels of various sizes and various grits of sandpaper disks.

If decay is left in a cavity, and the dentin has not been thoroughly sterilized, there is the possibility that the patient may suffer from a general systemic pathologic condition, brought about by the lack of thorough removing, cleansing and sterilization, of the remaining dentin. Not only this, but if all decay has not been thoroughly removed from the cavity, the carious process will continue under the filling, and eventually the pulp will become involved. Thus, a vast number of people are suffering health impairment from infectious dentin under fillings. I wonder what the physicians would say if they knew that this were true.

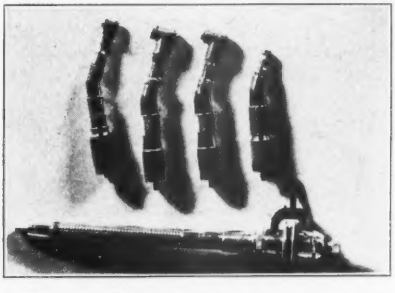

Fig. 18.—Types of handpieces used in making slice.

Never place a permanent filling in a tooth without first removing the last bit of decayed dentin and thoroughly sterilizing the remaining dentin with ammoniated silver nitrate, neutralized with formalin or oil of cloves. Never fill a tooth that has been filled with amalgam

or any other filling material without first removing the remains of the filling to see if there was not decay left under the filling.

Figures 10-11, from Black's "Operative Dentistry," volume 1, show the filling of the dentinal tubules with microorganisms. The dentino-enamel junction is at the top. The organisms have entered the tubules and, by continued growth and multiplication, have filled and enlarged them uniformly, having grown single file into all of the small side branches. Only in a few cases is slight local swelling of tubules seen. At left, near the margin of the invaded area, new tubules are as yet but partially filled. Great differences are found in the various specimens in the

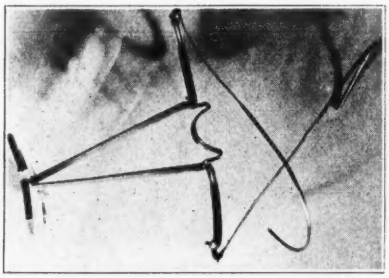

Fig. 19.—Binocular glasses.

smaller side branches. Some show very few organisms after passing a little way from the dentino-enamel junction.

The best and safest way for everybody concerned is to remove the last bit of decay in all preparations (Black) at the expense of the pulp. If the operator finds extensive decay, and the pulp apparently is not affected, but to remove the very last bit of decay, in all probability, involves exposure of the pulp, it is good practice to treat the dentin with ammoniated silver nitrate, turning the light in the cavity for about two minutes and at the same time keeping it free from saliva. Turning the light on the silver nitrate in this manner causes it to penetrate the unhealthy dentin remaining in the cavity. After neutralizing with formalin or oil of cloves, I protect the pulp with a lining of copper cement, as a temporary filling, allowing this to remain for several months. This gives the odontoblastic cells an opportunity to fill in with secondary dentin. I then remove the lining of cement and carefully cut away the remaining soft dentin with a sharp spoon excavator, repeating the application of silver nitrate,

Fig. 20.—Left, slice extension lap preparation plus box form cavity. Right, typical box type or Black cavity preparation.

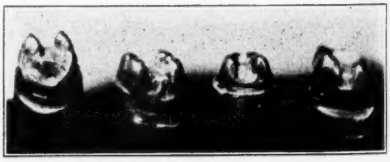

Fig. 21.—Amalgam dies picked at random from practical cases; illustrating slice used in preparations.

neutralizing and coating with cavity varnish. I use copper cement to replace the lost dentin and complete the cavity preparation for the permanent filling, provided, of course, the pulp is apparently healthy.

I much prefer the indirect method of impression taking, then registering the occlusion, the proper tooth form, embras-

ures and contact surface of the adjoining tooth in wax, which is transferred to the die or model and waxed. If we register the contact surface in the wax bite and properly carve the embrasures, it is rarely necessary to grind or add solder to this surface of the inlay. The contact surface will register plainly in the wax bite and is an exact reproduction of the contact surface of the adjoining tooth. This contact surface should not be disturbed. The wax should be carved away from the surface, only the flattened surface, which should be the final surface of contact, remaining. In the finishing and polishing of the inlay, the contact surface should need no grinding, only a slight touching up with a cuttlefish disk and buffer.

With the indirect technic, the die or model is fine for grinding and finishing the inlay. I also believe that one can get better results in the final finish of the sharp margins of the lap of the inlay.

I do not know of a single case of occurrence or recurrence of decay around any margins of my inlays since I have been using the slice extension lap cavity preparation and restoration, and I have been using this type of preparation for about seven or eight years. It is just as possible to do careless restorative work with this type of cavity preparation as with the butt-joint type. Results depend on the individual operator himself.

The operator should check by the roentgen rays all compound inlays before they are seated permanently. Often, a slight overhang or defect will be found at the gingival margin, which can be detected by roentgenogram and corrected.

Cementing the inlay is a very important procedure. I much prefer a good copper cement, properly mixed, tapping the inlay to place with an inlay seater by short, rapid taps, vibrating the excess cement out and the inlay home.

The points of the two inlay seaters are of soft metal and the mallet is faced with leather, the purpose of which is to soften the blow. The instrumentarium consists of the metal strips which are used to gain access through the contact surface by a sawing motion, forcing the strip through the contact surface with the cutting surface of the strip toward the contact surface of the tooth to be prepared; three sizes of lightning disks mounted either on a mandrel or a straight or contra-angle handpiece; four sizes of wet or dry disks in the three grits, fine, medium and coarse; four sizes of craftsman's disks for heavy cutting; and right or contra-angle handpiece mandrels, in six lengths, ranging from three-eighths to one inch. A drawer in the cabinet especially prepared for mounted disks should be kept well filled by the assistant. These mandrels should be mounted with various assortments and sizes of paper disks about equally divided for push and pull cutting. Good handpieces, which are essential for good cavity preparation, should consist of at least three contra-angles, one for true stones of the large head type, one small head contra-angle for delicate cutting with short mandrels and burs; one straight angle handpiece for disks, and two straight handpieces. A technic should be developed to one's own liking with this assortment of handpieces. Each one of these instruments has advantages over the others; for instance, the small head contra-angle handpiece is especially good for making the slice in the bicuspid region. There are many other instruments used in this type of cavity preparation, too numerous to mention in this article. I especially wish to call attention to the set of hand cutting instruments designed by W. I. Ferrier, of Seattle, Wash. I believe that binocular glasses should be a part of one's equipment as one can see

things in detail with them that cannot be detected without them. Figure 19 compares the typical Black box type preparation and the slice extension lap preparation. Note how conservative the cutting of the dentin has been, and how with the slice it has been possible to follow out extension for prevention, and how the cavity proper is protected from recurrence of decay at all of the margins, especially at the gingival wall of the cavity. Figure 20, amalgam dies for practical cases, shows clearly the slice. Two of these are extreme cases, but in each of the dies we note the extension for prevention and how conservative the cutting of the dentin has been. The gingival wall is not flat in the two extreme cases. I am convinced that there is real merit in the slice extension lap cavity preparation and restoration. In my own mouth, the pulps of three teeth have been lost from decay occurring at the gingival margin of an inlay. In the future, I shall insist on the slice extension lap cavity preparation and restoration in my own mouth. I employ it in my own family, and recommend to you its adoption, trusting that you will get as much satisfaction out of its use as I have. I wish to acknowledge indebtedness to the following men for the knowledge I have gained in cavity preparation: the late G. V. Black, Edward R. Hart, Carl P. Knapp, E. T. Tinker, James Mark Prime and DeForest Davis.

SUMMARY OF ETIOLOGIC FACTORS AND RESULTANT LESIONS IN CANCER OF THE ORAL CAVITY, ESPECIALLY IN RELATION TO PREVENTION OF MALIGNANT DISEASE AND PRESERVATION OF THE TEETH

By JOSEPH COLT BLOODGOOD, M.D., Baltimore, Md.

THERE is still ignorance and skepticism regarding the relationship between cancer and the use of tobacco and the irritation from teeth or ill-fitting plates, in spite of the fact that clinical evidence, in more recent years, has been corroborated by experimental work in producing cancer in animals by irritation.

I believe that the dentist would be quite safe in guaranteeing the patient freedom from cancer if the patient would guarantee his seeing the dentist when the dentist advised and not when the patient felt he should visit him. My almost continuous studies of cancer of the mouth from 1892 to 1932 confirm this statement.

In more recent years, we have evidence that any person cured of a cancer of the mucous membrane of the mouth or lip runs more risk of producing a second cancer if he suffers irritation from tobacco, teeth or plate again. The longest interval in our experience is eighteen years; the shortest, two years.

Therefore, it is safer for any man or woman who develops cancer in a leukoplakia patch due to irritation by tobacco, teeth or plates, never to smoke again.

If the lesion produced by the irrita-

tion of tobacco, teeth or plates was not malignant at the time that successful treatment was instituted, there is less danger, after the disappearance of the local lesion, either because of removal of the causes or excision of the local lesion, or its treatment with roentgen rays or radium, in returning to smoking, provided the teeth are kept absolutely smooth and clean and there is no irritation from plates.

Women have demonstrated to men that it is possible to smoke with little or no danger of producing cancer, because the women who smoke today are under the care of dentists and are most particular about their teeth.

For many years, the dental profession did not realize or acknowledge the relationship between cancer and the irritation from tobacco, teeth and plates. This fact is best explained in this way: The majority of dentists never saw cancer of the mouth, because those who developed cancer never consulted a dentist; and when cancer developed, they waited until the lesion became so large that it was logical to consult a physician and not a dentist. In the time of Butlin, from thirty to forty years ago, the relation between syphilis and cancer of the mouth was exaggerated, and that between oral irritation from tobacco and the teeth and cancer overlooked. There was a time in this country when 90 per cent of lesions of the mouth which came under the observation of the surgeon were cancer, and 90 per cent of the cancers were hopeless. Today, the proper education of the community will reverse these figures and 90 per cent of the oral lesions will not be cancer, but local conditions which may precede cancer, or that have no relation to cancer. Education in most communities has gone so far that the majority of these local lesions of the mouth are first seen by dentists, and for this reason the dental profession has had forced on them many new diagnostic problems.

I propose, therefore, to give a brief summary of these local lesions which may precede cancer, may be cancer or may have no relation to cancer.

It is about three years or more since I wrote chapter 4 in volume 4, of "Practice of Surgery."[1] This allows me to confirm the statements made there, to make any necessary corrections and to add, at least briefly, new data.

LOCAL LESIONS OF THE ORAL CAVITY

Local conditions of the oral cavity are: Vincent's infection, leukoplakia, fibroma, irritation, hypertrophy of papillae, wart and papilloma, tuberculosis, stomatitis, fissure of the tongue, pellagra, leukemia, keloid of the lower lip, geographic tongue, hemangioma and lymphangioma (cysts and ranula), ulcer, syphilis, hypertrophy of labial glands, glossitis, bulging of the cheek, scurvy and subcutaneous benign tumor.

ORAL SURVEY

An oral survey is becoming a more difficult procedure, because more and more people are getting correct information regarding the danger of neglecting any spot in the mouth which they can see or feel, or which is sore whether they can see or feel it or not. I frequently say, in discussing the oral cavity before any audience—students, physicians or dentists, or lay audiences—that, previous to 1900, when we looked into the mouths of patients who consulted the surgeons or clinic at Johns Hopkins, we saw at once cancer and usually hope-

1. Practice of Surgery; edited by Dean Lewis, Vol. 4, Hagerstown, Md.: Prior & Co., 1930.

less cancer. When we cured cancer then, it was by a dangerous and mutilating operation. When I made a report in 1920 on cancer of the mouth, I stated that early cancer was on the increase. Even then, when we examined the mouths of our patients, cancer was still the predominant lesion; but hopeless cancer was no longer the predominant lesion, and many more cancers were operable or within the possibility of a cure by radium. By 1922, in my clinic, the predominant lesion of the mouth was leukoplakia in men, many of these referred to me by dentists. The patients' physicians and dentists had told them to stop smoking and many of the dentists had cleaned the patients' teeth. This change came very quickly after the war. The daily press could say more about cancer of the skin and mouth than it would say about cancer elsewhere, and it is not out of place here to record that the percentage of early cases of cancer or lesions which precede cancer depends on the space given to that subject in the public press. At the present time, least space is given to cancer of the cervix and cancer of the stomach, and the percentage of early operable and curable cancer of the cervix and of the stomach is least in this country and all over the world.

By 1924, the most frequent lesion of the mouth was a sore spot due to the organism of Vincent's infection. Both the dental and the medical profession gained a new and vast experience with this in the trenches in France. I had so rarely seen Vincent's infection, or I had failed to recognize it when I did, that in my publication on cancer of the tongue in 1920, in discussing cancer of the tongue as a preventable lesion, I did not mention Vincent's. This now common lesion of the mouth has never been omitted since in my publications.

Today, the most common lesion of the oral cavity is a sore spot in the mouth of a woman, and it is very difficult to see anything wrong in the spot which, the patient asserts, is sore. This explains why the oral survey is becoming more and more an important and integral part of a physical examination when the patient makes no complaint of any trouble in the mouth, and a much more difficult diagnostic procedure when the patient complains of a sore spot in the mouth which shows nothing or only an area of slight irritation, or when one finds slight hypertrophy of the papillae.

In the oral survey, one should see with the eye and feel with the finger the entire mucous membrane of the oral cavity anterior to the fauces. To make this survey complete, the tonsils, pharynx, nasopharyngeal area and nares should be inspected and the sinuses transilluminated. This, of course, is best accomplished by a dentist and nose and throat specialist; but the time must come when the dentist will extend his survey to cover the ground of the nose and throat specialist, and the specialist to cover the ground of the dentist, and the general practitioner, and other clinicians will cover the ground of both, since this careful survey of the oral cavity, as stated before, is becoming an essential part of a general physical examination and a very difficult achievement in patients who have slight complaints of sore or slightly changed spots in the oral cavity.

Both physician and dentist should more frequently palpate the mouth, at least up to the sensitive areas in fauces and pharynx, and it is often best to benumb those sensitive areas by local anesthesia to allow palpation. Now that we are seeing local disease in its

earliest stages, a very short time after the informed patient has become aware of the spot, our diagnostic procedures must be changed to meet the new demands. The vision required to see a fully developed local lesion must be trained to the requirements of a less distinct area. The sense of palpation that with no difficulty discovers a definite lump must be further trained to detect the indefinite, but yet distinctly palpable, area of change. One must become more familiar with the normal through inspection and palpation within the mouth. In addition, we must acquire experience and precision in the use of instruments in the interests of diagnosis, better lighting and transillumination; roentgen-ray films and cover slips, and in study for the presence of organisms. We must use more often all the laboratory tests. We must learn the necessity of determining the cause and character of an obscure spot in the mouth, in order to extend our diagnostic search all over the body. No oral survey is complete without roentgen-ray films of the teeth. Very often, we must add to this roentgenograms of the sinuses, no matter what transillumination reveals, and of the jaws, with later a view of the skull and the chest.

The interpretation of many cases of bone lesion has been incorrect or has been deferred through neglect of a study of the blood chemistry and a search for the possibility of enlargement of the thyroid, parathyroid glands or the pituitary body.

It is impossible, of course, and, if possible, not necessary, to make such extensive and expensive diagnostic surveys as a routine part of an annual physical examination, or even as a part of every oral survey. It requires great experience and judgment based upon accurate knowledge of the actual lesions and the possibilities in relation to the actual spot in the mouth to know when the range of the diagnostic survey shall be extended. When a local lesion is evidently that of Vincent's infection, leukoplakia, fibroma, keloid, a wart, papilloma, geographic tongue, hemangioma or lymphangioma, one can concentrate attention on the local lesion and its treatment; but when there is an ulcer, one must think of tuberculosis, syphilis and other types of infection or conditions such as pellagra, scurvy and leukemia. When there is a slight area of irritation, the search must be continued until the cause is found.

RULES OF TREATMENT DURING THE DIAGNOSTIC SURVEY

In the majority of cases, it does no harm to advise discontinuation of tobacco in all forms. On first inspection, cover slips can be made to ascertain the presence or absence of Vincent's infection, so that treatment with sodium perborate can be begun at once. If the teeth need cleaning, that can be done after the first brief survey. A thorough cleaning of the teeth, with the routine treatment of Vincent's infection if the spirillum is present, is an essential feature in every lesion of the mouth and an important part of the preparation for operation or the application of radium. Often, with cessation of the use of tobacco, the cleaning is a diagnostic test in an area of irritation. The presence of the spirillum of Vincent does not mean that this infection is the sole cause of the mouth condition, and not until the teeth are thoroughly cleaned and every crevice and crack in or about the teeth is disinfected with sodium perborate can we tell with any certainty whether Vincent's infection is the sole cause of the trouble.

If the presence of plates is a possible cause of the trouble, they should be tem-

porarily removed for a therapeutic test and properly adjusted. Even today, the majority of dentists and physicians do not feel the teeth for sharp or ragged edges and do not smooth these edges when the teeth are cleaned. When extraction is the method of eliminating irritation by a tooth, this should be done at once. Again and again, in this country, and even more frequently in the clinics in Paris and London that I have just visited, I find a small or large area of cancer under expensive radium treatment with the teeth still irritating the malignant area. To repeat: Before any operation or any radium treatment and often even before biopsy, the teeth should be smoothed, cleaned or extracted, just as the plates should be temporarily removed.

In some of our largest public hospitals where there is plenty of radium, the most expensive electrical surgical appliances and a large enough staff of radiologists and surgeons, the personnel to carry out the cleaning, smoothing and extracting of teeth is conspicuous by its lack of numbers or its absence.

All these working rules of treatment should be carried out with precision and rapidity and in proper sequence as the diagnostic survey goes on.

In the enthusiasm for radium treatment in oral lesions, it is often forgotten that the best and most economic method of eradicating the local spot, no matter what its nature, is complete removal under local anesthesia with the knife or the electric needle, by endothermy or coagulation, or with the electric cautery. When this is done, the margin of excision should be sufficient to eliminate malignancy if the ultimate section proves its presence. It is quite possible to arrange for immediate frozen sections of the area removed, to determine not only its pathologic nature, but also the sufficiency of the margin given the lesion. These operations are just as easy and efficient in the dental chair as the extraction of a tooth or the incision of a root abscess. As the majority of dentists work in the so-called dental and medical art buildings, it should not be difficult to provide them with a pathologist, who could have his office in the building. In the absence of that convenient and economic arrangement, the dentist should be able to take his patient to the operating room of a hospital provided with a pathologic laboratory or bring the pathologist, with frozen-section apparatus and microscope, to the dental office. The modern dentist has already provided himself with much more expensive apparatus in his own office.

The protection afforded the patient by the services of an expert pathologist, skilled in making frozen sections during the operation, no matter where it may take place, is well within the means of any private patient. If this is not possible, it is much more economical for the community to have that patient go into a public hospital or endowed clinic where he can have the benefit of this protection.

If the patient is an adult, no matter how well the teeth look and no matter even if there have been roentgenograms taken within the past six months, this examination should be made at once. These films not only reveal root abscesses and recession of the gums, but often disclose overlooked cavities in a tooth. It keeps the patient and the dentist pretty busy taking smears for Vincent's organisms, cleaning and smoothing teeth, extracting as necessary, taking and interpreting films, and filling cavities or repairing plates. Then there must be immediate decision as to other laboratory investigations. Often a complete gastro-

intestinal study must be made. Many lesions of the mouth accompany some form of gastro-intestinal defect. So far, I have never observed them in association with cancer or ulcer, so there is no particular danger to the patient if this gastro-intestinal study is omitted or deferred. Nevertheless, it improves the morale, shortens the period of neurasthenia and allays fear to find the cause of the trouble in the mouth promptly and relieve it readily. Conditions of the tongue, such as glossitis, stomatitis, fissure, cracking or swelling of the tongue showing the markings of the teeth or plate, various types of coated tongue are all associated with some form of indigestion. One of the most difficult conditions to handle is that form of indigestion associated with overweight and lack of exercise, and that associated with neurasthenia and fear. One of the last tests that may have to be resorted to is the basal metabolism test. In my experience, hypothyroidism is rarely associated with lesions of the mouth. In toxic goiter, the most common trouble in the mouth is neglect of the teeth by the patient, due largely to fear of dental work.

THE FEAR OF CANCER

Apparently, the two factors in bringing patients in after the first warning, in the stage best suited for successful treatment and often the most difficult period for diagnosis, is correct information and a sufficient amount of fear to urge the patient to seek the advice of a dentist or physician at once. An attempt to allay fear should begin at once. In these very early cases, the dentist or physician can say, the moment the first survey by inspection and palpation is over: "There is no evidence of cancer"; for if the lesion is cancer, it will be brought out only at biopsy or after complete removal. I find that there is little difficulty in allaying fear, if one proceeds rapidly and thoroughly with the diagnostic survey, follows the working rules and adapts one's conversation to the requirements of the patient's mental attitude.

BIOPSY

Should the lesion which is of a size permitting its complete removal with a sufficient margin prove to be malignant, there need be no biopsy, although, as stated before, it is safer to have an immediate frozen section made to determine the nature of the pathologic process and define the margin of uninvolved tissue. If the complete removal of lesion is to be mutilating, or if treatment by radium or the roentgen-rays seems to be that of choice, there is apparently no danger in nor objection to immediate biopsy.

In London, I observed that a number, perhaps the majority, of those using radium in the skin, oral cavity or cervix delayed biopsy until after the first radium treatment. This is a problem that will be discussed later in detail. What has been stated here is the correct working rule for the majority of local lesions in the mouth.

Biopsy has shown its greatest value in the past in tuberculosis lesions of the mouth, because the moment the microscope shows the tubercle, rarely is further operation indicated. When the ulcer is small and painful and can be excised without mutilation, its complete removal with the electric needle or cautery relieves pain and hastens healing.

THE WASSERMANN PLUS REACTION

The point of view, the extensive writings and the position of authority of the prominent students of mouth lesions forty years ago, have been harmful when cancer is observed in a stage in which operation or irradiation when applied

immediately offers a large probability of cure. In those early years, when practically every case of cancer of the mouth was hopeless, the therapeutic test undoubtedly did more good than harm. It put off the mutilating and distressing operation, or, in some instances, saved the patients from going through this ordeal; but, in early cancer of the mouth, a delay for a therapeutic test is often dangerous. The patients whose blood Wassermann reaction is positive are just as apt to have a malignant condition of the mouth as a benign one. Syphilitic patients often have enlarged tongues, fissured and cracked, and these tongues are more subject to irritation by tobacco, ragged and dirty teeth and ill-fitting plates. Butlin and those early day observers were right in their conclusion that syphilis is a factor in cancer of the tongue, but how that factor worked was apparently not so clear to them as it is to us, and syphilis is much less frequently a factor in cancer of the mouth today than at the time of Butlin.

In 1924, from tables made by my dental associate, Victor H. Long, I ascertained that the percentage of positive Wassermann reactions in all lesions of the tongue, whether benign or malignant, was 13, while in lesions in other areas of the oral cavity, the plus reactions dropped to 3 per cent. This is proof that the Wasserman reaction is not of itself particularly helpful in diagnosing lesions of the mouth.

In volume 4, chapter 4, p. 27, Lewis' "Practice of Surgery,"[1] the positive Wassermann percentage should read 13 instead of 20 when the lesion is on the tongue, and 3 when the lesion is elsewhere.)

Multiple mucous patches in the mouth are practically never confused with malignant areas. Their reaction to the therapeutic test is immediate. If the Wassermann reaction is plus in a lesion of the oral cavity, and the lesion is single, I would perform a biopsy before excision or institution of radium treatment.

In the past few years, the number of cases of oral lesions associated with positive blood Wassermann reactions has been growing smaller and smaller, and, in the great majority of these, the local lesion is either cancer or some condition that may be looked on as precancerous.

CONCLUSION

We will have to discuss in a second paper the various local lesions in the oral cavity, practically all of which have been mentioned in this paper. With each one, it will be necessary to emphasize the extent of the oral survey and the proper working rules of treatment, and to consider again both biopsy and the Wassermann reaction in each type of lesion.

EDGEWISE ARCH MECHANISM: A CASE REPORT

By ALLAN G. BRODIE, D.D.S., Chicago, Ill.

The case to be reported has none of the spectacular features so common to this type of presentation. Indeed, it was selected for an entirely different reason: to point a moral that unless a man is fairly well grounded in orthodontic theory, it is best for him not to try to treat malocclusion, regardless of how simple the case may appear. Before presenting the case, let me recall a few of the facts which orthodontists must understand if they are to succeed.

We know that there is a state of balance which should exist in the normal denture, and we know further that a lack of this balance, either through an increase or a de-

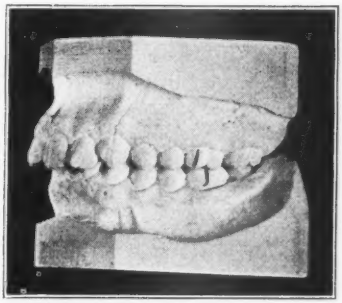

Fig. 2

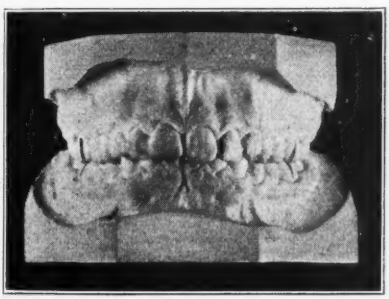

Fig. 1

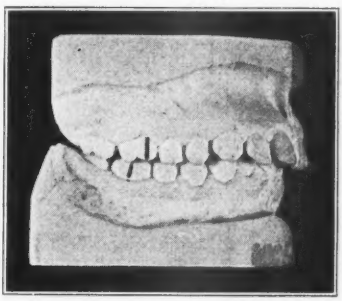

Fig. 3

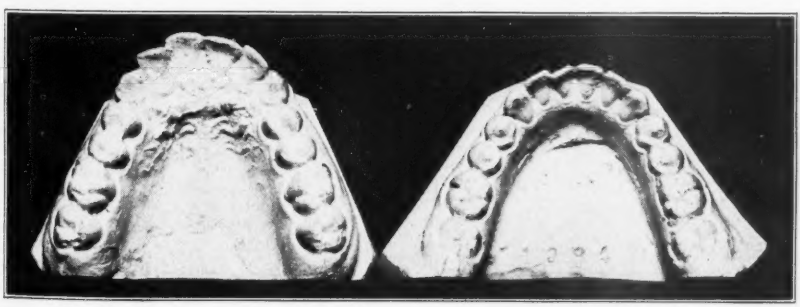

Fig. 4

Figs. 1-4.—Four views of case showing conditions before treatment.

crease in any of the forces will lead to malocclusion. Thus, in a buccolingual direction, we have the tongue within, supporting the crowns of the lower teeth, which, in turn, support the upper teeth through the inclined planes. The upper teeth are acted on by the labial and buccal musculature, which exerts a pressure inward. If, for any reason, lingual support is withdrawn from the upper teeth, there is bound to be a slipping of contacts in the arch and a subsequent crumbling, always provided the musculature remains normal.

The case in question is of this type; a Class II case with the mandible one full cusp distally from its normal relation with the upper. The patient, a girl, is a normal breather and the lips have apparently been kept closed.

The upper arch, robbed of its lingual support, has cracked at some time, but the remarkable part has been that only one tooth, the upper right central incisor, was thrown out of the arch. Why this is so we can only guess, the most plausible reason being that its space was partly closed before it erupted.

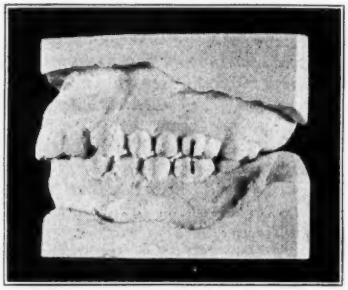

Fig. 6

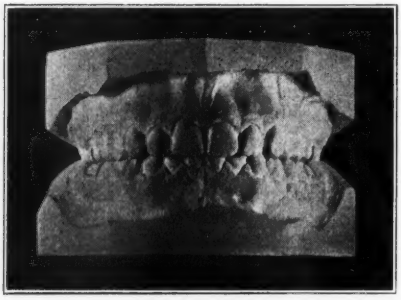

Fig. 5

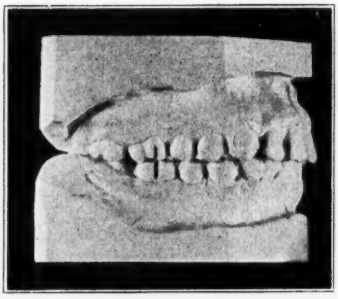

Fig. 7

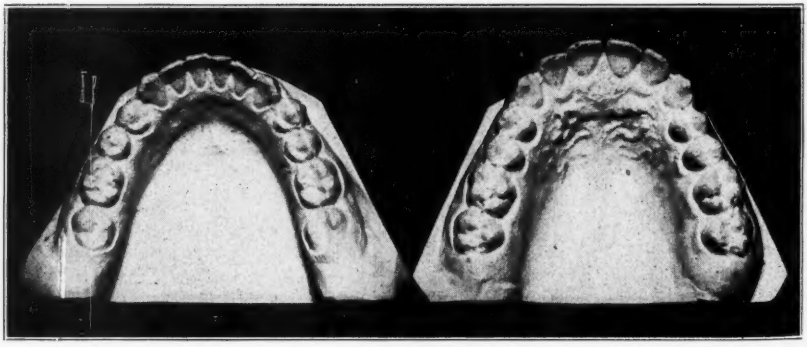

Fig. 8

Figs. 5-8.—Four views of case showing conditions two years after treatment. No retention was used in the upper jaw.

At any rate, the squeezing action exerted on this tooth caused it to project until it was almost horizontal.

This case was referred to a general practitioner, who saw only that one tooth and attempted to treat it. For ten years, he alternately opened the space, pushed the tooth back and retained and released it, only to have it "pop out" again.

The patient was finally referred to me, and the treatment followed was typical of Class II, division 1 treatment with the edgewise arch. This has appeared in the literature several times, so I shall not repeat the steps. Suffice it to say that it took nine appointments over a period of six months to reduce the malocclusion. Feeling that the cause of the condition had been corrected, I placed no retention bands on the upper jaw and there has been no tendency for the rebellious central incisor to revert to its former position.

The first four pictures, which show the case as first seen, are somewhat misleading. There was a retaining band with two spurs on this tooth, which I removed just prior to taking the impression. In spite of this, the tooth is tipped labially, although not to the degree that it became tipped each time it was released. Unfortunately, no records had ever been kept, and I have only the parents' word for the previous appearance of the case.

The last four pictures show the case as it now is, two years after treatment.

THE REMOVAL OF BROKEN HYPODERMIC NEEDLES*

By EARLE H. THOMAS, M.D., D.D.S., LL.B., F.A.C.D., Chicago, Ill.

HYPODERMIC needles may be broken off deep in the tissues in every area about the mouth where a needle is inserted to anesthetize the tissues. The locality in which this most frequently occurs is that region of the throat where the inferior dental nerve enters the ramus of the mandible, this being the site of the so-called mandibular injection. There are three main reasons that a needle is most liable to be broken in making this injection:

1. The needle is inserted more deeply into the tissues in this region than in others.

2. Unless warned in advance that the needle will touch the throat, the patient does not associate this sensation with any operation on the teeth and, thinking that the needle has slipped, may become alarmed and make a quick movement of the head to avoid the needle.

3. The anatomy of this region is less familiar to many dentists, and they are therefore more likely to strike the bone unexpectedly with the point of the needle thus causing it to buckle and break.

I shall discuss the technic of removal of a broken needle from the throat. The same principles apply in its removal from any other region about the mouth.

The basis of the technic is to obtain as efficient localization as possible by roentgenographing from two or more angles. As a knowledge only of the relationship of the needle to anatomic landmarks, as indicated in the roentgenograms, is usually insufficient for accurate localization, the usual procedure, before taking the roentgenograms, is to attach some radiopaque substance to or in the tissues as close to the broken needle as possible. A metallic guide such as a hypodermic needle

*Read at the Thirteenth Annual Meeting of the American Society of Oral Surgeons and Exodontists, Memphis, Tenn., Oct. 17, 1931.

is often used for this purpose, being inserted into the tissues as near the site of the broken needle as possible. Sometimes, two or three hypodermic needles may be used, a short distance apart. Once in a while, it might be better to use a metallic wire as one would a suture, tying a loop to the overlying tissues at one or more locations. Various types of instruments may be used.

While taking the roentgenograms, it is important that the tissues be kept in the relationship that will obtain during the progress of the operation. As, in most instances, the mouth will be open, a mouth prop is used. If the mouth were kept closed at this time and open during the operation, the localization of the needle might be inaccurate.

The lateral roentgenogram should be taken with the film parallel to the middle plane of the head and the rays directed exactly at right angles to the film; in other words, the two rami of the mandible should be exactly superimposed. The needle shadow may be several centimeters off from a localization standpoint if the roentgen rays were directed in the usual manner of taking a picture of one ramus of the mandible; i.e., by directing the rays from underneath the ramus nearest the x-ray machine and thus throwing its shadow out of the way. With the mouth open and the roentgenogram taken with the two rami superimposed, the lateral view indicates the exact distance of the broken needle from the guide needle or metal (superior, inferior, anterior or posterior).

In addition to the relationship in these directions, one must also determine the distance of the broken needle from the bone and the distance buccally or lingually from the guide needle. This information may be obtained by any one of several different methods:

1. An anteroposterior view, with the face on the film and the rays directed through the back of the head. The rays should not be directed through the middle of the head nor parallel to the sagittal plane, but on a plane parallel to the lingual surface of the ramus of the mandible.
2. An anteroposterior view, with the back of the head on the film and the rays directed through the face. In taking this view, the rays are directed through the middle of the head.
3. A view with the head thrown back as far as possible, the film against the top of the head and the rays directed from a position near the chest and projecting through the base of the tongue toward the film.
4. A dental film placed under the lower border of the mandible, the x-ray machine over the top of the head and the rays directed downward and parallel to the inner surface of the ramus.
5. A dental film placed on the outside of the face so that its margin compresses the soft tissues at the posterior border of the ramus, the rays being directed posteriorly through the open mouth and parallel to the inner surface of the ramus.
6. A dental film placed in the mouth near the third molar region in a vertical position at right angles to the inner surface of the ramus and the rays directed forward from behind the ear.

From a practical standpoint, only two views are necessary to localize a broken needle previous to the operation for removal: the lateral roentgenographic view first described, and any one of the other six views which proves to be satisfactory.

Any further check which may become necessary during the operation will usually be made to determine whether the broken needle is superior, inferior, anterior or posterior to the guide needle; that is, according to the technic described in

this paper. This information can be obtained by a lateral view, but instead of using a large roentgen-ray plate, one can use a dental film, placing it in the throat, compressing the tissues slightly in order to hold it in a vertical position and then directing the rays at right angles to the film.

If one does not follow the technic described in this paper but tries to cut distally directly toward the supposed location of the needle, with unsuccessful results, he will want a roentgenogram to check up to determine whether the needle is toward the buccal or the lingual aspect of the area of tissue opened up. This check is made by folding a metal back dental film so the two metal sides of the fold are in contact, inserting it in the incision and roentgenographing from one side and then from the other without moving the film.

In the operation for the removal of a broken needle, one does not insert a knife deeply into the tissues at right angles to the needle and then cut downward or upward, as the case may be, until the knife comes in contact with the needle. Such a method is mechanically sound but is not good surgical procedure. There are many important structures to be considered during the operation, the most important of which are the lingual nerve, the inferior dental nerve, the inferior dental artery and the pterygomandibular ligament. The responsibility of the operator concerning the first three structures is obvious, but few operators seem to consider the undesirable results that often follow the incision of the pterygomandibular ligament, that important structure which unites the superior constrictor of the pharynx and the buccinator muscle. If this ligament is severed, in most cases it is almost an impossibility to suture it in the proper relationship, and the postoperative result is a ptosis of the soft palate on that side.

To avoid this ligament and the lingual nerve, which may have various sites close to the surface, the incision is begun buccally from the third molar region and extended upward along the anterior border of the ramus, thus being in cheek tissue for almost its entire length. The incision is very shallow, just through the superficial tissues, and, from this region, the operation proceeds by blunt dissection only.

The tissues are dissected a short distance above and below the level of the broken needle and this area is extended posteriorly along the inner surface of the ramus next to the periosteum but not elevating it from the bone. This is continued until the tissues are opened to a point opposite the middle section of the broken needle.

When this point has been reached, it is evident that the broken needle must be lingually from the area opened by the blunt dissection and the roentgenographic localization should indicate fairly accurately its position in relation to the metal landmarks, which are still in position.

Continuing the blunt dissection lingually toward the area where the broken needle must be, the operator picks up one layer of tissue after another, separating but not cutting the fibers, until contact is made with the needle or the needle is seen.

Usually, by this technic, the proximal end of the broken needle comes into view. If the middle part of the needle is exposed first, a tenaculum is used to pull forward the overlying tissue or the blunt dissection is continued until the proximal end is reached. This end of the needle is then picked up with tissue forceps or a hemostat and the needle is withdrawn from the tissues. If a hemostat is em-

ployed, one must use care to avoid compressing the needle appreciably or it may break, because, if it is made of steel, the inside may be rusted to such an extent as to make it frail. I recall removing one needle which was so rusted that only a thin outer shell remained, an amount of metal insufficient to show up clearly in a roentgenogram.

When the advice is given to expose an area of tissue buccally from the broken needle and then, by a process of blunt dissection, work toward the lingual aspect, until the needle is exposed, one who has had a little experience in this work is liable to laugh and say, "It sounds easy, but that is not the way it goes." Such an operator has probably used a haphazard method of locating the needle or dissecting the tissue. If localization has been accurate and one follows the definite system of first opening the tissues buccally from the needle, working lingually through the tissue must expose the needle.

By obtaining accurate localization, as described in this paper, and by carefully following this technic of operation, it is possible to remove a large percentage of broken needles within a few minutes. Failure may be due to careless dissection of tissue, but usually will follow inaccurate localization. In following this definite technic, the more time one spends in obtaining the most accurate localization possible, the less time will be required to complete the operation.

The statement has been made that one should use blunt dissection entirely. Sometimes during the progress of the operation, it *does* become necessary to cut across some of the tissue, but to assure avoidance of any of the important structures in that area, this tissue is picked up in small sections and examined from every angle before being incised.

During the course of the blunt dissection, the uninitiated may be bothered by the fact that every fiber of tissue that slips over a pointed instrument will give a click which suggests, in sound and the accompanying feeling, slipping over a needle. This sensation will be partially avoided by the use of a fairly heavy instrument for the blunt dissection. One soon learns to rely on sight, not on sound or feeling. Even then, the glistening fibers of tissue often deceive by their resemblance to a needle.

As one becomes more proficient in searching for needles, the cross area of tissue opened up will be less and less; likewise, the depth to which the tissues are opened, and one soon reaches the point in proficiency where he searches for the proximal end of the needle only. This usually has the appearance of a black speck, the size of the cross-section of the needle, and so all clicking and all glistening strands of tissue are completely ignored.

During the course of the blunt dissection, the lingual nerve is usually exposed, and it is then held to one side by a blunt retractor, as are likewise the inferior dental nerve and artery if they interfere with the dissection. The advice was given not to cut across the pterygomandibular ligament. In most instances, one can approach the needle through the triangular space above this ligament, but, in searching for needles broken off very low in the tissues, one may have to lift this ligament upward and outward and work underneath it.

Procain anesthesia is used for these operations because its use allows the utmost cooperation of the patient, which is a great aid during the operation. The procain solution should contain a high percentage of epinephrin, which makes the field of operation comparatively bloodless.

Sponging of the field is necessary, and here a word of caution may be of value. No large packing of gauze should be forcibly pressed into the wound. Such a procedure may result in forcing the broken needle farther into the tissues, thus disturbing the previous relationship which has been so carefully ascertained. The use of loose cotton is preferable as gentle pressure will easily make it conform to the shape of the exposed surfaces.

After the needle has been removed, if a large area of tissue has been involved, the tissues are sutured and a small gauze drain is inserted to the depth of the cavity. If only a small area has been opened and trauma has been kept at a minimum, no drain nor sutures are necessary, and there will usually be little postoperative reaction. If an abnormal reaction does follow, a gauze drain is inserted and drainage maintained until all acute inflammation has subsided.

If there has been considerable trauma, the resulting scar tissue may cause trismus. After all inflammation has subsided, this can be taken care of by stretching the mouth open with a mechanical mouth gag. Naturally, the more definite the technic, the less the amount of trauma, and therefore the less the postoperative reaction. With proficiency developed along this line, patients will have practically no postoperative reaction.

Various causes for the breaking of needles in the tissues during a hypodermic injection, and methods of avoiding such mishaps, have been covered in a previous paper.[1]

Most needles which I have removed were far from where a needle should be if inserted in the proper location to obtain efficient anesthesia. A few had the point inserted into the temporomandibular joint; many were lying crosswise of the coronoid process and above the level of the sigmoid notch; several were extending a short distance behind the posterior border of the ramus, and some were inserted below the lower border of the ramus. In the majority, the point was even with the posterior border of the ramus, thus being inserted a considerable distance past the normal point of injection.

The fact that I describe only one technic for removing these broken needles does not mean that I am not familiar with others. I have tried every method that has come to my attention, including several which were the product of my own "mistaken ingenuity." My experience has proved to me that the technic herein described is the most satisfactory. It has always been successful, the needle being recovered with the most precision, the greatest speed and the least postoperative reaction.

We are often asked about the use of the fluoroscope and the magnet. The fluoroscope is practically useless in this work, but a powerful magnet may be of assistance if the needle is made of steel.

If it is difficult to get the patient's cooperation or insure a bloodless field, especially in removing needles broken in making the lower injection for tonsil operations, radio head-phones will aid one in determining when contact is made with the needle. I have not found it necessary to use these for the past few years. In using phones, no batteries are necessary. One terminal wire is held in the patient's hand and the other attached to the exploring instrument. Whenever this instrument touches the needle, a click or scratching sound can be heard in the phones. One can determine in advance just what kind of sound is heard. The

1. Thomas, E. H.: Oral Surgery Conditions of Interest to General Practitioner, J. A. D. A., 16:1997-2004 (Nov.) 1929.

procedure is as follows: Have someone hold a needle between the fingers of one hand and one wire of the phones in the other, then place the phones over the ears, touch the other wire against an instrument, and move the instrument along the finger, holding the needle until contact is made.

Often the question arises as to whether steel needles are the only ones that break in the tissues. Such is not the case. If a platinum needle is bent several times, it will weaken and is liable to break. Also, heating a platinum needle past the point of dull red heat will make it brittle and just as liable to break as a steel needle; and we all know that few dentists remove a platinum needle from the flame before it passes the point of dull red heat.

There is also the question as to whether it would be harmful to leave a broken needle in the tissues. For several reasons, my advice is that they should all be removed. They can move through the tissues considerable distances because of the action of the muscles around them, and it is quite possible for them to penetrate important structures, such as the carotid artery, with fatal results.

One needle which was removed in our office had worked its way down into the inferior dental canal and was impinging on the inferior dental nerve, causing considerable pain.

While a needle remains in the tissues, a clever lawyer can picture a situation having untold and dangerous possibilities, and the result may be a large judgment against the dentist. If the needle has been removed all that a patient can hope to collect will be operation expense and the value of time lost from work. For the latter reason, if for no other, the dentist who gives any attention to the business side of his practice will be sure to have a broken needle removed at the earliest possible opportunity.

One last word of advice may save some dentist much anxiety and his patient unnecessary suffering or complications, and, at the same time, make the removal of a broken needle a less difficult procedure for the surgeon. A dentist who has not had considerable experience in oral surgery work, especially in the region of the throat, should not make even the slightest attempt to remove the broken needle, nor should he allow any inexperienced surgeon to do so. There are many reasons for this statement, and it is made with due consideration. The majority of dentists who have had the misfortune to break hypodermic needles will, I am sure, agree that this advice is invaluable.

DISCUSSION

Joseph P. Wahl, New Orleans, La.: The only statement I do not agree with in Dr. Thomas' paper was that this work is easy. Anyone who does this work knows that it is not easy. I believe that removing a broken needle requires the most skilful technic at our command. If the needle is long and in an easily accessible location, it is an easy matter, but the last type that Dr. Thomas spoke of, in the soft tissues around the tonsil region, presents great difficulty. Localization of broken needles is a very important part of the procedure. Once we determine just where a needle is, it may or it may not be an easy matter to remove it. Dr. Thomas said nothing about the magnet. Although a great many men use the magnet, I have never found it of much value in removing a needle which is deeply imbedded. Pieces of steel, etc., are removed from the eye with the magnet, but getting them out of the tissues in the region of the mandibular fossa is quite a different matter. An interesting point was the bending of the film. I have never seen that done and I think it is an excellent idea if one can learn to use it as Dr. Thomas does. I was wondering how he got it into the incision. If it can be held it place, it would be a great help. Steel needles, if they are left in any length of time, are much harder to remove than iridioplatinum needles. I was called on to remove

one a few months ago which had been broken off for a year and which somebody else had tried to remove. This needle was very much rusted and just had to be cut out.

E. C. Hume, Louisville, Ky.: I know of nothing that is quite so annoying as to have one of these broken needle cases referred when you are busy, your time is already booked up and the patient and his doctor are frightened and very anxious to have the needle removed at once. For years and years, Dr. Thomas, Dr. Blum and other men have said that, in the event you are not familiar with this type of surgery and you have a needle break, you should let it alone and refer the case to someone who knows how to take care of it. The temptation to attempt removal is great, the operator reasoning: "I just put the needle in; there is the opening, and I can make a little incision and get at the needle." If the case has been traumatized and the patient is uncomfortable, sometimes it is a good policy to prescribe for the patient or have the man who performed the original operation prescribe for him and allow the present trauma to clear up before making a further attempt. Some of these patients come into my office the following day unable to open their mouths, and it is impossible for anyone to make an examination of the posterior part of the mouth. In those cases, I advise letting the needle alone until I am able to make an examination, because, to me, the important thing is to have that patient's mouth open and in the position in which you are going to operate when you take the roentgenogram. I wish to emphasize this point, as made by Dr. Thomas: It is utterly useless to try to localize a needle with the mouth closed and then expect to find it in the same place with the mouth open. Another thing that I wish to emphasize: The needle had better be removed, as it has been definitely proved that these needles do migrate.

Henry B. Clark, St. Paul, Minn.: I want to thank Dr. Thomas for describing this technic to me several years ago, and for again giving it to us now. It has been possible for me to try it a number of times, and at this time I feel that it cannot be improved on and that it should be the standard method of procedure in dealing with these accidents. The man who breaks a needle in the tissues should refer the case (if he feels that is advisable) only to someone that he knows can handle it properly, because the courts have decreed that he is responsible for damage done by any operator to whom the patient is directly referred. We all know of cases in which greater damage has been done by inexperienced people trying to remove needles than could have been done by letting them alone. In fact, it is probable many of them would never cause any trouble if left alone. It is best to remove them, human nature being what it is, and in view of possible claims for damages if they are left, and any sort of nervous disorder occurs. By the method just described, needles are often removed, and so little disturbance follows that patients do not even favor the operator with a postoperative call.

Theodor Blum, New York City: Only men who have done a great deal of this work can appreciate the work Dr. Thomas has done in the removal of broken needles. I am speaking from an experience in removing 121 broken needles. The remarkable thing to me is that I have done my work in my way, successfully, I think, and Dr. Thomas has done his work successfully in an entirely different way. Of these 121 needles, I missed one altogether, a platinum needle broken into two parts. I worked an hour and a half and the patient refused to allow me to continue. This is not an excuse on my part: I may never have found it. In another case, a steel needle had broken into three parts. The patient had been operated on before. I was able to get only one piece out, the first one, when the patient refused to allow me to continue. I think that a record of 121 cases, with one and two-thirds failures, is not bad, and still I have never used a guide to take out these needles. Dr. Thomas is entirely right in continuing to do his work by the method with which he is most successful. This is a very important point for those of you who have not done much of this work. Remember what Dr. Thomas has said: Read what other men have done, and always collect all the information possible. Dr. Thomas says, for instance, that the use of the fluoroscope is of no advantage; and so I thought before I used it. In one case, a needle was broken off in the mandible and was not found on operation. It was posteriorly from the inferior dental canal, where I looked for it and could not find it. When I took a roentgenogram, I found it posteriorly, in the soft tissues. The motion of mastication had pushed it back. This was the only case in which the object had moved. I have taken out needles which had been in the same posi-

tion for years. In that case, the roentgenologist used the fluoroscope, he marking down on the surface the position of the needle, and there was no difficulty in removing it. I did not quite understand where Dr. Thomas starts the incision.

Dr. Thomas: I start buccally to the third molar.

Dr. Blum: I have never done that unless I thought that the needle was there. I had one case in which a small part of the needle was left close to the coronoid process. I try to avoid going very far up, because the buccal fat, if we get close to the upper part, will drop down and be quite troublesome. I make the incision as far back as I possibly can, and so come very close to the middle of the needle. I am wondering whether Dr. Thomas uses the back of the scalpel, turning it around and separating the tissues that way. This is a very satisfactory procedure and a great help. The remedy for this condition is the prevention of the accident. Of the 121 needles, there were exactly 101 in the mandible, and of the number that were removed, there were only two or three heavy steel needles. All the others were thin steel needles, and about six or seven iridioplatinum needles. My advice to the general practitioner, therefore, is to use heavy steel needles for a mandibular incision. I always ask the practitioner who has this accident to send a complete history of the case, as to what instruments were used, how the injection was made, what method, etc., and I find that most of the men use a thin steel needle. I feel that this is wrong. An experienced man can inject successfully with a thin needle, but for the general practitioner, I think, the heavy steel needle, with the method I have described, is the safest. There are many things that are responsible for the accident. At times, the needle is caught between the lingula and the bone, and if not there, in that heavy, dense attachment of the temporal muscle which comes down on the inner side along the internal oblique line. If we approach from the opposite side—and I am not saying this because I consider my method best—we have to go through a great deal of tissue before we strike the bone, which sometimes is sensitive, and if the patient at that time moves suddenly, the needle will break off, but if we hurt the patient while in contact with the bone at the internal oblique line, it is in only about 0.3 cm.

Menifee R. Howard, Denver, Colo.: I have found that the guide, as suggested, is of great value. I wish to ask Dr. Thomas a question that often arises in these cases: Should we accept a fee from the dentist for this service, or should we look wholly to the patient?

Dr. Thomas: Dr. Wahl spoke about the magnet. Unless a powerful magnet comes within about a quarter of an inch of the needle, it will exert practically no pull whatever on that needle. If the needle is in the tissues just an eighth of an inch under the surface, a powerful magnet may be of service. It should be pressed against the tissues of the throat and then pulled away, and if it pulls the tissues up, we have a rough idea of the location of the needle. If we are working down in a deep place, where we can scarcely see, working blindly, and we finally think the needle is loose, a magnet used in the cavity may pull the needle out; that is, if the needle is loose. If the needle has not been disengaged from the tissue, the magnet will not pull it out. Localizing the needle during the operation by means of a film bent double, inserted in the incision and roentgenographed from one side and then the other, is an exceedingly valuable procedure. I forgot to mention one thing in this connection. One should take an explorer and place it through one corner of this film before placing it in the incision. This is for the purpose of disclosing the relationship of the film to the tissues. We prefer to take these needles out without anyone having previously operated. If we have a case that has not been touched, we are often able to get the needle out within ten minutes, but when the tissues have been cut to pieces, and the incision has been made at the wrong place, the case becomes more complicated. Another thing: it is very difficult to blunt dissect scar tissue. In some cases, one of the most difficult things is to get the patient to cooperate with you. Dr. Blum mentioned a patient's quitting before he had finished. If the patient acts in such a manner that we must anticipate his doing this, we may lose our heads a little and do things that we would not do otherwise. We do not take our time and go carefully, step by step, until we get to the needle but probe around indiscriminately and are liable to end by not getting it. In connection with Dr. Blum's discussion: I do not know how many needles I have taken out; I have never counted them. When I got back from the Minneapolis meeting, there were four waiting to be taken out. Sometimes, we take out

two or three in one week, and maybe a month or two passes and we do not get any; and again we perhaps have one every day for a week. I was interested to know that out of 121 of Dr. Blum's cases, 101 were mandibular needles. That agrees with what I said in my paper; these cases are by far the most frequent. If there is anything that "riles" me, it is to have a man get up in a meeting and take the attitude that this method or that method is not any good. Therefore, when I go before a society and say, "My method is good; I can do so and so," that does not mean that every one else is wrong. Dr. Blum's method may be better for him—it has to be good for he has practically 100 per cent success. I do it another way, and I have 100 per cent success. I never say any one else's method is not so good or is wrong. Dr. Wahl said that I made only one mistake, and that was in saying that the method was simple. This technic is rather simple, I think. One other thing: Stereoscopic roentgenograms can be of great help, if you have a man who makes good ones.

OPERATIVE CARE OF MENTAL CASES*

By DONALD S. BARTLETT,† D.D.S., North Chicago, Ill.

MEDICAL and dental literature contains little relative to prophylaxis and the treatment of caries and oral disease in mental cases. In discussing the operative care of these patients, it is not my intention to tell you that the dental department of the mental hospital can effect cures or "near" cures in any case or group of cases, but I do hope to leave the impression that we render a necessary service to every patient in the institution.

During the last two decades, the relationship of psychiatry to general medicine and dentistry has been generally recognized, and the present age sees these three branches of the healing art dependent one on the others. While a mental hospital is primarily concerned with the treatment of the patient in whose clinical picture mental symptoms predominate, physical disabilities are also present; and thus a mental hospital must be equipped with the facilities for diagnosis and treatment that are to be found in a well-organized general hospital.

The organization and equipment of the dental department of a mental hospital should be in keeping with the modern standards established for all other departments and should be second to none in location as to light, ventilation and ease of access from all hospital wards. Its staff should consist of a sufficient number of experienced dentists, dental assistants, hygienists and technicians to care for the needs of the hospital population.

Many conditions found in mouths of mental patients may be found as well in the mouths of patients making up the practice of the average general practitioner, and the actual mechanical procedures involved in their treatment ordinarily present nothing unusual. The problems arising in rendering treatment

*Read before the Section on Operative Dentistry at the Midwinter Clinic of the Chicago Dental Society, Jan. 19, 1932.

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to mental patients involve more than the treatment of existing dental conditions, as such. The first consideration is the behavior of each patient as he is presented to the dental clinic. Is it such as to permit a complete clinical and roentgenographic examination? If it is, the examination is made; if not, the patient is referred back to the ward physician with the request that he be returned to the clinic as soon as his condition will permit the examination. Although in some instances the behavior of the patient is such as to prohibit constructive treatment, we are able to examine satisfactorily fully 90 per cent soon after their admission to the hospital.

CLASSIFICATION OF CONDITIONS AND FORMS OF TREATMENT

1. Good contact with external reality:	All forms of dental treatment
2. Disturbed, excited	Mild: Constructive dental treatment
	Medium: Constructive dental treatment at proper intervals
	Severe: Exodontia; palliative treatment (frequently under suitable restraint)
3. Deteriorated, advanced stage	Moderate: Sensible operative treatment; exodontia
	Vegetative:
	Passive: Sensible operative treatment; exodontia
	Active, resistive, noncooperative: Exodontia; palliative treatment under suitable restraint

Immediately after the examination, a detailed report is sent to the physician in direct charge of the case, enumerating every abnormality found in the oral cavity and including the necessary recommendations for treatment. Prior to instituting treatment, with the exception of relieving immediate discomfort, a consultation with the physician is essential, for it is during this consultation that we are acquainted with the outstanding facts of the patient's general condition and we outline to the physician the necessary dental treatment.

In attempting to describe the operative care of mental patients, I hope to correct the erroneous opinion that once a person enters a mental hospital as a patient, little dental treatment can be rendered and that only in the form of extraction and for the relief of pain. It should be understood that whatever treatment may be indicated, placing the mouth in a healthy, useable condition is given every consideration. In general, this takes the form of the removal of infected teeth, roots, impacted teeth and those so affected with pyorrhea that treatment is of no avail, and includes the insertion of fillings and inlays of various types, the treatment of periodontal disease and, when the masticating surface is so depleted as to impair proper digestion, placing of crowns and bridgework. I shall attempt to explain to what extent such dental treatment may be given and what results can be expected. In doing so, some mention must be made of definite mental disorders. I shall make no attempt to enumerate and classify the manifold diagnoses met in the average mental hospital, but will say that, in general, the beds are occupied by patients having dementia praecox of various types: the manic depressive group and those suffering from epilepsy, general paralysis or organic brain disease. Regardless of the diagnosis, we are governed almost entirely in the planning and rendering of

dental treatment by the patient's behavior. The accompanying table gives in outline a classification of conditions and forms of treatment.

You will at once note that no mention is made of diagnosis, for when considering dental treatment, we can classify, with very few exceptions, the entire hospital population on these characteristics of behavior.

With patients in Group 1, no particular difficulty is encountered, as they are as a rule cooperative and anxious to have treatment, and we may therefore proceed with such dentistry as is necessary for the elimination of infection and restoration of the masticatory apparatus. It is comparatively easy to create in them a desire for a clean mouth and, after being instructed, they will make reasonable efforts in the daily care of the teeth.

It is the patients in Group 2 that we must give careful consideration. The mouths in these cases present various abnormal conditions, from simple occlusal cavities to veritable cesspools of infection. It is our duty to give such treatment as will assure a clean, healthy oral condition. Consider first the mildly disturbed person: his characteristics of abnormal behavior may not be manifested to any noticeable degree while he is in the dental chair and he usually cooperates with the dentist during treatment. In these cases, we can do such operative work as is indicated, and should extensive restoration of masticating surface be necessary, dentures may be made and inserted and will be used with as much satisfaction as those of patients in private practice.

The disturbed or excited patients whose condition I have termed "medium" are perhaps the group which must be given the most thought, their behavior often being most changeable. One patient may march to the dental chair, boldly tell us to go as far as we like and actually appear to enjoy whatever form of treatment we may at the time be rendering, while another may show the opposite attitude and we must listen while he tells us that his teeth are all right, that they are being treated by radio, that we must not touch his teeth for they belong to the Kaiser, etc. With persuasion, we may be able to begin treatment and, during subsequent sittings, we must expect to follow a similar procedure until all feasible dental treatment has been completed. The next patient in this group may absolutely refuse to submit to any form of treatment and whatever our persuasive explanation, it will be of no avail. Any attempt to render treatment is useless, and if no emergency exists, the patient is returned to the ward. Two months later, his conduct may be so entirely changed that he cooperates readily; and thus by prolonging treatment and using tact and patience, we can usually accomplish our desired results.

With the severely disturbed, treatment is of necessity limited. A patient of this type may be extremely hyperactive, talkative, noisy, negativistic or possibly combative. Even so, he must not be permitted to endure pain, and foci of infection when present in the mouth must be removed. If, after proper sedative treatment by the physician and his physiotherapy aides, the patient does not submit to dental treatment, suitable restraint may be used. Fortunately, this severely disturbed stage is usually transitory, and we may later have an opportunity to treat the patient under more favorable conditions.

With the deteriorated group, our hopes for accomplishment are of necessity greatly limited. The behavior of these patients shows a progressive impairment of intellect, memory and emotions manifested possibly to the extent that they either do

not realize disease conditions exist or they do not care. With the moderately deteriorated, we experience little difficulty in the removal of infective foci and the insertion of fillings of various types, but the absolute lack of cooperation on their part precludes the possibility of replacements of any nature. They must be permitted to retain every tooth that can possibly be saved without immediate jeopardy to health. As the need arises, extractions can always be accomplished. The treatment of periodontal diseases in these patients is a most important factor in their welfare. The necessity for such treatment is always in evidence, but owing to the lack of interest on the part of the patient, ideal results are hard to achieve.

The so-called vegetative group is even more difficult to handle. With the exception of the passive person, for whom we may render treatment similar to that of the moderately deteriorated, we can do little other than extract teeth and alleviate pain, and this, many times, must be done under suitable restraint.

I have previously attempted to correlate our treatment with the patient's characteristics of behavior. In some instances, the patient's disability confronts us as the deciding factor in treatment; for example, in cases of epilepsy, syphilis, neurologic disorders and tuberculosis. The epileptic, as we all know, wears removable dentures at a risk, as they may become dislodged during a seizure and there may be serious results. For the restoration of lost masticating surface, fixed bridgework wherever possible is indicated. We never place a removable denture in the mouths of these patients without the knowledge and consent of the physician who has observed him in his seizures and is in direct charge of his welfare.

Prior to instituting antisyphilitic treatment by the use of mercury in any form, the patient's mouth should be placed in a clean, healthy condition, and it should be closely watched during his course of treatment so that a high standard of mouth hygiene is maintained. If this procedure is carried out, cases of salivation and mercurial poisoning will be greatly reduced.

Patients suffering from various neurologic disorders are many times hard to treat. Particularly is this true of cases of advanced encephalitis lethargica, a common residual condition after sleeping sickness. The copious flow and viscuity of the saliva is peculiar to these patients and they are practically helpless in combating unhygienic mouth conditions. To give them treatment is a task, yet constant vigilance and care is necessary, much of which must be the responsibility of a well-instructed ward personnel.

To the mental patient afflicted with pulmonary tuberculosis, special care and attention must be given. Frequent bedside visits for the relief of discomfort are necessary. If the patient's physical condition permits, we do everything possible toward the removal of infective foci. The repair of carious teeth seems to be a never-ending procedure. As these patients are particularly susceptible to infection, a high standard of mouth hygiene must be maintained; for periodontal disease once started develops rapidly owing to lowered resistance and, if permitted to continue unchecked, greatly retards recovery.

I have mentioned various diseases and abnormal conditions and their subsequent treatment but would fail completely if I did not offer some form of prophylaxis. We have worked out a system whereby every patient has his personally marked toothbrush and every ward has its cabinet in which the brushes are kept and cared for. These cabinets vary in size from the

100-brush cabinets to the smaller ones holding twenty brushes, the interiors of which are so arranged as to prevent any brush from coming in contact with another. Each cabinet is equipped with a metal container in which is kept at all times a fresh 10 per cent solution of formalin. This container is concealed within the cabinet and is inaccessible to the patient. The results of a series of bacteriologic examinations have proved these cabinets to be very satisfactory.

Routine toothbrush drills are held daily in all ambulatory wards. Under the direct supervision of the nurse in charge, each patient is given his brush by one attendant, while another stations himself by the wash bowls, distributing tooth paste, directing its use and collecting the brushes. The importance of these toothbrush drills need not be emphasized. The fact that some attempts to use the toothbrush may be of little value is accepted, although a poor attempt is better than none and this activity aids greatly in reducing that vicious cycle of oral decay in mental cases.

In the conduct of a private practice, the dentist is dependent for success on the cooperation of his assistants and his patients. In a more specific way, the success of the dental clinic in a mental hospital is dependent on the cooperation of the other departments of the institution and particularly that of the nursing staff and attendant personnel, for on them rests the responsibility for the patient's promptness in meeting appointments, postoperative care and the supervision of prophylaxis.

The aid received from the bacteriologic and pathologic laboratory is invaluable. It supplies us with an always current list of serologic examinations that have shown a positive syphilitic reaction, makes the occasional dark-field examinations in suspicious lesions that may be found in the mouth and examines the many smears taken in suspected cases of Vincent's infection, and it is to this department that we send questionable patients for coagulation tests prior to extensive extraction.

I have in general touched on the dental conditions met in the mental hospital daily and have attempted to show what operative care mental patients should receive; elimination of infection, repair of injury and disease, preservation of the masticating apparatus, prosthesis and surgical work, and I have emphasized the need of prophylactic measures. The direct value of our efforts toward the return of these patients to society is problematic, but we do know that mental disabilities are not stationary, but are all responsive to outside stimuli, and since the benefits of our treatment are easily demonstrable from the point of view of organic and physical repair, we have a right to assume that it may be of value to that unfortunate group afflicted with the various forms of mental disease.

I have tried to explain what may be accomplished in the mental hospital. I only wish that I could assure you that it is being done in every mental institution throughout the country, but statistics would belie the statement. From the latest report of the U. S. Bureau of Census, we obtain the appalling statistics that for 250,000 mental patients cared for in 164 state hospitals only ninety full-time dentists are employed. The State of Illinois hospitalizes 20,530 mental patients in ten different state institutions and employs only eight dentists, two of whom are part time.

The patients composing the population of these hospitals are taken from a cross-section of American life and are deserving of more dental treatment than so few

dentists can possibly give. This fact being recognized, there is before the dental societies throughout the country an additional task—that of sponsoring a movement whereby an adequate dental staff shall be provided each institution.

INLAY CASTING*

By HERBERT D. COY, D. D. S., Hamburg, Iowa

ACCORDING to authorities, inlays of glass and porcelain were made more than 100 years ago.

In his "History of Dental Surgery," the late C. R. E. Koch states that gold was used as a filling for carious teeth as early as 1450.

The first gold inlay is supposed to have been made by a gold foil operator who, when he dislodged a filling in finishing and polishing it, cemented it into place, and thus gave us the gold inlay. From the ill luck of this gold foil operator, as we are led to believe, through many variations, extensions and experiments, we have produced a scientific technic for the casting of a gold inlay.

Research into the various casting technics prevalent today has revealed to the careful reader of dental literature the fact that many, or shall I say all? of our current casting technics have been based more largely upon personal opinion than on a sound foundation of scientific facts.

Many conflicting opinions and statements were formerly in existence. The knowledge available regarding the physical characteristics of the materials used in dental casting was very indefinite, these conditions making it necessary for some agency to search for the truth.

The Research Commission of the American Dental Association therefore made an appropriation, arranging with the National Bureau of Standards at Washington, D. C., for an impartial survey and investigation, hoping to standardize dental materials and to establish definite specifications.

The furnishing of scientific data on the physical characteristics of materials rather than the working out of methods of procedure or some certain technic is the aim of the Bureau of Standards.

Many of the dental materials on the market were of very low quality, and the dentist could determine their usefulness only by experimenting on his patients; which resulted in injury to many teeth and many mouths.

A great expenditure of money has been made in the past by the dental profession in vain attempts to solve the problems of dental casting, although scientific study of methods or materials was practically unknown. We have purchased equipment and many special devices on the recommendation of this clinician or that, paying a generous fee for an intensive personal demonstration, only to learn that he has not based his operation on scientific facts, the results obtained leaving much to be desired.

This accounts for the present cooperation of a number of widely scattered den-

*Read before the Section on Operative Dentistry at the Midwinter Clinic of the Chicago Dental Society, Jan. 21, 1932.

tists with the Bureau. A comparison of the various casting methods and materials can be made impartially by these workers, who are not affiliated with any commercial interests.

Although a few of the manufacturers have employed trained workers, who have improved their employers' products, personal endorsement is still being stressed by salesmen, rather than physical properties of the materials, and technics are still being urged on us which have no scientific foundation.

The cooperative research program on dental inlay materials and technics was undertaken by the Bureau of Standards and a cooperative committee of the American Dental Association, with several objects in view when they set to work in April, 1929.

The combined groups over the country have about 200 members at the present time, who make up the cooperative committee.

The National Bureau of Standards is an impartial body. We all know something of the incomparable facilities at its command for the carrying on of its work, from a machine that will measure a millionth of an inch to another as large as a house. While we as taxpayers are supporting it and while commercial interests generally have made use of its many facilities, the dental profession has been very slow to take advantage of its marvelous and unbounded resources. It has nothing to sell and nothing to gain because of its activities. Its sole object is to establish the facts as it finds them.

It has been very free to commend the parts of the various casting procedures which it has been able to verify, and equally ready to condemn that which it has proved to be false; an attitude causing enmity in certain quarters.

The results of this research have been published from time to time in THE JOURNAL.[1]

I would urge each of you to give these articles careful consideration. A fifth specification to cover dental inlay golds was prepared by the Bureau and presented to the profession at the annual meeting of the American Dental Association at Memphis.

The specifications for investments are covered by the following requirements as given in an article written by N. O. Taylor, research associate for the American Dental Association and the National Bureau of Standards of Washington, D. C.[2]

A satisfactory investment should have sufficient thermal expansion to compensate for a considerable portion of the casting shrinkage of inlay golds. It should not contract during the setting period and should not show marked irregularities in volume change in heating.

1. The setting expansion shall be 0.05 per cent or over, at the end of twenty-four hours.

2. The thermal expansion shall be 0.7 per cent or over, when heated from room temperature to 1300 F. A thermal expansion curve or sufficient data shall be supplied to enable the purchaser to make proper use of the material.

3. During the preceding test, the specimen shall not, at any temperature above 400 F., show a length shorter than the original length at room temperature, and shall not at any higher temperature show a shrinkage or decrease in length of more than 0.15 per cent of the maximum length at any lower temperature.

4. The compressive strength shall not be less than 300 pounds per square inch.

1. Taylor, N. O.: Specifications for Dental Amalgam Alloys, J. A. D. A., 17:112 (Jan.) 1930. Taylor, N. O.: Paffenbarger, G. C., and Sweeney, W. T.: Dental Inlay Casting Investments, J. A. D. A., 17:2266 (Dec.) 1930: Specification for Dental Impression Compound, ibid., 18:53 (Jan.) 1931; Specification of Inlay Casting Wax, ibid., 18:40 (Jan.) 1931.

2. Taylor, N. O.: Standards for Dental Materials, Iowa D. Bull., 17:94 (Aug.) 1931.

5. The time of set shall not be less than five nor more than thirty minutes and shall be indicated on the package. The time of set shall not vary more than 20 per cent from the manufacturers' stated value.

Rough castings may result from the use of coarse investments. Some manufacturers advocate a fine inner investment and a coarse outer one, but laboratory tests gave no basis for this recommendation and the requirements are based upon a single type of investment whose fineness shall be as follows.

6. Eighty-five per cent shall pass a No. 200 sieve, 95 per cent shall pass No. 100 sieve and 100 per cent shall pass a No. 30 sieve. The general requirements for investment are as follows:

1. The material shall not crack in heating.

2. The material shall not contaminate the alloy cast into it and shall not cause pitting, roughness of surfaces or voids in the alloy.

3. When heated, the material shall not give off poisonous or offensive odors.

TENTATIVE SPECIFICATIONS FOR DENTAL INLAY WAX

1. The waxes should soften without becoming flaky or laminated.

2. They should be sufficiently plastic at temperatures slightly above mouth temperature to permit forcing them into all the details of the cavity walls.

3. They should harden sufficiently at mouth temperature to permit withdrawal from the cavity without distortion.

4. They should carve without chipping and flaking.

5. The color should be such that it facilitates the carving of the pattern in the mouth through contrast with the hard and soft tissues of the mouth.

6. The thermal expansion characteristics should be known to insure correct use of the materials in any technic requiring wax expansion.

Flow tests were developed for the determination of rigidity and working range. Thermal expansion determinations were specified to provide other necessary data. These detail requirements are:

1. Flow at mouth temperature. Samples 1 cm. in diameter shall not shorten more than 1 per cent in length when subjected to a load of 2,000 gm. for ten minutes at 99 F.

2. Softening point. The softening point of the materials shall be between 100 and 108 F.

3. Working range. The material shall soften sharply and a working plasticity shall be obtained at or below 112 F.

4. Thermal expansion. A curve or numerical data shall be supplied with the material which will enable the purchaser to make the proper use of the material in technic requiring wax expansion.

These requirements, if followed, will serve to eliminate the large number of excessively soft waxes on the market as well as a few which are too hard. The soft waxes are the more dangerous variety, since an inlay technic can give results no better than the original wax pattern. If it is made of soft material and is warped or distorted in withdrawal from the cavity, poorly fitting castings will be the inevitable result.

The group of workers with whom I have been associated is under the able direction of Charles E. Woodbury, Council Bluffs, Iowa. The findings and the technic which I shall present to you are the combined results of our cooperative efforts.

The method by which we have obtained the best results gives consideration to both the thermal expansion of waxes and the setting and thermal expansion of investments.

It has been proved by investigation, both by the Bureau and other investigators, that the shrinkage of gold from the molten state to the point of crystallization is approximately 1.25 per cent per volume of the gold.

Extensive experiments have proved that the shrinkage of gold is practically constant when the temperature varies from the lowest degree at which it can be cast to the maximum temperature obtainable with a good blowpipe, using hydrogen and compressed air.

The properties of wax patterns are such that it seems far more desirable to obtain the major portion of the compensation by the expansion of the investment

rather than to risk distortion of the thin and plastic wax pattern.

The ideal investment would be one in which the setting and thermal expansion combined would equalize the deficiency caused by the shrinkage of gold.

Experiments are now being conducted looking toward the perfection of such a product. Casting will then be greatly simplified and an inlay that fits will become a certainty rather than an accident.

At the present time, there is no investment that has enough expansion to compensate or offset the shrinkage of gold in all cases. This condition makes it necessary to utilize the thermal expansion of wax to some extent, although this should be confined to a minimum.

The investments that have the greatest amount of thermal expansion have been found to be those of high silica and low plastic content. Silica is an expanding material; plaster, a contracting material.

All the investments listed by the Bureau of Standards as those most nearly meeting their requirements have a high silica and low plaster content. They all have a progressive expansion. By this, I mean that the higher the temperature to which they are heated, the greater the expansion, reaching the maximum at red heat.

If an investment is to be desirable for use in a wax expansion method, it must also be slow setting, so that the heat used in expanding may have time to penetrate to the pattern before the initial set of the material. Shrinking investments are those of a high plaster content. The use of these with wax expansion seems always to result in undersize castings. No scientific evidence has ever been presented that would warrant the use of this type of investment. Neither does there seem to be any advantage to be derived from the use of a double investment.

Nothing original is claimed for the technic herewith presented. Scientific facts taken from the above-mentioned articles, furnished by the Bureau of Standards and verified by many castings made independently in the laboratories of the cooperative committee, have furnished a basis for the method.

Preparation of all cavities, where an inlay restoration is indicated, should be made by the method as outlined by G. V. Black in his book on operative dentistry. It should be so formed that all the walls will be slightly diverging and free from undercuts, as from this type of cavity the wax pattern may be readily removed. The walls must be smoothed with stones and chisels and the cavosurface angles accurately beveled and finished.

The preparation of a well-finished cavity is absolutely essential in the production of an ideal wax pattern. This preparation is made easier by the application of the rubber dam. It is my opinion that the making of a true wax pattern is the most difficult part in the procedure of making an inlay.

Since wax is a plastic substance and changes form whenever subjected to change in temperature, it is essential that whenever wax is placed in a cavity in the mouth, it should not be chilled by the use of cold water or air, but it should be held under pressure until sufficient time has elapsed for it to assume mouth temperature.

The pattern should be carved to form. When the carving is completed, the proximal surfaces of the pattern should be polished with linen tape. A solvent such as eucalyptus or oil of cajuput is not to be used.

The completed pattern should be removed from the cavity whenever possible by attaching the sprue and then gently applying force rather than by the

use of an explorer. It should then be washed with a solution of equal parts of hydrogen peroxid and green soap, rinsed with room temperature water and dried with a slight application of air from a syringe. The pattern is now ready for investing.

Any of the investments which meet the tentative specifications of the Bureau as previously outlined may be choosen.[3] The greater variation will be found in the amount of water necessary in the mix, and in the setting time.

As a matter of convenience, I shall choose Ransom and Randolph's green investment. The inlay ring to be used should be lined with a thin layer of sheet asbestos and the ring sealed to a small metal slab with beeswax. The lining should be moistened with water, so that the water content of the investment will not be changed when poured into the ring. The investment will then be mixed, 16 gm. of water to 50 gm. of investment being used, the amounts being doubled if necessary to fill the ring.

If wax expansion is necessary, the water used in the mix should be warm enough that the finished mix of investment is approximately the same temperature as the expansion bath.

It should first be spatulated by hand, then by the use of a mechanical device such as the Whip-mix or Kerr for 100 revolutions of the handle, or about 30 seconds. It is then vigorously vibrated on the lathe to remove any remaining air bubbles. The ring is then vibrated full of investment, more of which is formed on the pattern by a camel's hair brush, care being taken not to trap any air. The pattern is now gently vibrated into the investment-filled ring until the sprue former base is seated. A clamp is now adjusted to hold the base and the ring securely together. Plaster bowl and spatula should be dry and clean when the mix is begun.

The investment is placed in the water bath for twenty minutes, or until set.

After removal of the metal base, the sprue former base and the sprue pin, the invested pattern is placed in a furnace for fifteen minutes at a heat of approximately 500 F. The heat is then raised to 900 F. for fifteen minutes, then to red heat, at which point the casting should be made, the investment reaching its maximum expansion at that heat.

The type of casting machine to be used makes little difference and is not considered a variable.

The amount of water used in the mix may be varied to suit the convenience of the operator, but it should be continually kept in mind that the smaller the amount of water used, the greater the thermal expansion of the investment and the smoother the finished casting.

Rough castings are usually caused by one of the following:

Excessively vibrating.

Use of an unclean pattern.

Air being incorporated into the investment.

Too high a proportion of water in the mix.

Burning out too rapidly.

The various individuals and the groups of the cooperating committee presented clinics at the Memphis meeting of the American Dental Association under the direction and with the assistance of the Bureau of Standards and perhaps the many ideas and technics may be harmonized into one ideal method of casting and adopted by the profession as a standardized technic.

3. Footnote 1, second reference.

CAVERNOUS SINUS THROMBOPHLEBITIS: REPORT OF CASE

By GEORGE A. HECTOR, D.D.S., and SQUIRE BOZORTH, M.D.,* Portland, Ore.

ANATOMY

SITUATED on each side of the body of the sphenoid bone is a large paired sinus which extends from the sphenoid fissure to the apex of the petrous portion of the temporal bone. The cavernous sinus differs from the other intercranial sinuses in the fact that its cavity is subdivided by more fibrous strands, which form spaces and meshes on its interior. The lateral wall of the sinus, the most distinct, contains the oculomotor and trochlear nerves and the ophthalmic divisions of the trigeminal nerve. The medial wall is not distinct, but is formed by the structures which it contains: the internal carotid artery, abducent nerve and the cavernous plexus of the cervical sympathetic.

The cavernous sinus receives the venous blood return from a widely distributed area. Through the medium of the ophthalmic veins, its tributaries and related facial veins, the eye lids, the cheek and the external nose are drained through the cavernous sinus. From the mucous membranes of sphenoidal and posterior ethmoidal air sinuses, numerous small veins pass through the bony walls. On the other hand, there are small veins which transverse the foramen ovale, and foramen Vesallii, and communicate with the pterygoid venous plexus situated in the infratemporal fossa. Thus, the cavernous sinus is brought into indirect venous relation with the soft palate, the fauces, the pharynx and the alveolar processes of the upper and lower jaw. In the event of septic thrombosis from a primary focus in any of these areas, the cavernous sinus may become secondarily infected, through the medium of the inferior ophthalmic vein and the pterygoid venous plexus.

The following case is an example of infection of the cavernous sinus which followed operation about the alveolar processes of the maxilla and mandible.

REPORT OF CASE

History.—E. T., a woman, white, 46, was admitted to the hospital Feb. 24, 1932, the chief complaints being pain in the back of the neck, headache and toothache. The patient felt well until February 15, at which time a right maxillary tooth became painful. Camphor was rubbed on the gum of the offending jaw and the patient obtained temporary relief. Later, the symptoms returned in the jaw and pain radiated to the left side of the neck, the right maxillary sinus area and the side of the head. The past family and medical history was essentially negative.

Physical Examination.—The patient, who was acutely ill, was well developed and well nourished. The head was normal, with no gross external changes. Examination of the eyes revealed no changes of a pathologic nature. The right ear drum was slightly retracted but otherwise normal. The pharynx showed some evidence of postnasal discharge, and the tonsils were cryptic and moderately infected. The nose did not show any gross pathologic change. The cranial nerves re-

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sponded normally There was a marked tenderness of the left side of the neck with rigidity and pain on rotation. Pain was marked on pressure over the cervical spine and muscles of the left side of the neck. The chest, heart and abdomen showed no changes. A healed midline abdominal surgical scar was present. The temperature was 101.6 F.; pulse 76; respiration, 24; blood pressure: systolic, 140; diastolic, 80.

Cytologic examination of the blood revealed: hemoglobin, 85.9 per cent; red blood cells, 4.16; white blood cells, 10,350; polymorphonuclear neutrophils, 66 per cent; small lymphocytes, 12 per cent; monocytes, 3 per cent; staff cells, 13 per cent. The sedimentation rate at fifteen minutes was 75 mm., and at forty-five, 109 mm. Urinalysis showed acetone++++, diacetic acid+++, pus+ and epithelium+. The Kahn and Kolmer tests for syphilis were negative. Roentgenograms of the cervical vertebrae showed no evidence of injury or pathologic change.

In view of the foregoing, it was felt that the cervical spine was affected, especially on the left side, either with an inflammatory disease of the bone or synovitis of the upper cervical vertebrae. Subsequent roentgenograms failed to reveal any bone changes, and medical treatment did not improve the condition of the patient. Attempts to locate possible foci were next instituted.

Examination of the mouth revealed the presence of three maxillary molars, two deciduous cuspids and one bicuspid. A full complement of mandibular teeth were present. Many of the teeth were deeply carious. The mouth hygiene had been neglected and the gingival tissues showed marked peridental inflammation with pocket formation, especially around the posterior teeth present. There was no evidence at the time of the examination of any fistula formation and percussion failed to yield any response. Roentgenograms revealed a marked loss of alveolar bone about the maxillary teeth and the presence of an unerupted maxillary right cuspid, which was lying horizontally in the alveolar process. There was no evidence of any cuspid formation in the left process. The maxillary right lateral was devitalized and the apex was hidden by the root of the unerupted cuspid. In view of the foregoing, and after consultation with the medical staff, it was decided that the possible foci be removed from the mouth. From the time of entrance to the date of oral interference, the patient had a low grade septic temperature with peaks of 101.6 F, and a low of 97 F.

Operation.—On March 2, under nitrous oxid and ether anesthesia, the maxillary teeth were removed. It was decided at the time of the operation to remove the mandibular third molars and central incisors which were deeply carious and showed evidence of excessive bone loss. The impacted tooth was found lying close to the apices of the teeth and midway between the labial and lingual plates of the alveolar process. One suture was placed to hold the incised tissue in apposition and no drains were placed. The operation was completed in thirty minutes and the condition of the patient was good at the conclusion. The pulse rate was 156, respiration, 26.. Four hours after the operation, the temperature had fallen to 96 F., which was lower than any previous temperature taken. The patient was seen the same afternoon and there was no hemorrhage and the tissues were in good apposition. There was a slight edema of the right cheek and it was noticed that the patient kept her right eye closed during the entire examination of the mouth. The edema at this time did not appear to involve the orbital tissues.

Course.—The patient was next seen the following day. She appeared very toxic, with a blood pressure of 80 systolic and 48 diastolic, distended abdomen and a marked increase in heart rate. The entire right eyeball appeared to be pushed forward as if by pressure posteriorly. The pupil of the right eye was sluggish to light and the palpebral conjunctiva was chemotic. The extra-ocular movements were limited and blindness even to light was present. Examination of the left eye was negative. Rhinoscopy performed by us at this time revealed the presence of dark sanguinous casts in the nose, which, after removal, left a raw bleeding surface. Pus was seen coming over and under the middle turbinate. Roentgenograms of the ethmoid and sphenoid sinuses revealed a definite haziness of the right ethmoid sinus. The impression at this time was that the proptosis of the right eye was secondary to either rupture of an ethmoid or a sphenoid cell or cavernous sinus thrombophlebitis of traumatic origin.

Cytologic blood examination at this time revealed a leukocyte count of 17,050 cells; polymorphonuclear neutrophils, 61 per cent; small lymphocytes, 2 per cent; monocytes, 11 per cent; staff cells, 28 per cent, and disintegrating cells, 8 per cent.

In view of the clinical and roentgenographic findings, immediate partial exenteration of the ethmoid and sphenoid sinuses was decided on. The anterior tip of the middle turbinate was removed and partial exenteration of the anterior and posterior ethmoid cells was carried out. Marked pus formation with polypoid degeneration was present. The anterior wall of the sphenoid sinus was opened and a hyperplastic membrane revealed. No sedatives were used before or after the operation because of the toxic condition of the patient, and the operation was performed under local anesthesia. After the operation, the patient became irrational with an increased rapid pulse and a marked lowering of the blood pressure (80, 40). Six hours later, death ensued.

Necropsy.—This was performed eight hours after death, with the following findings: When the tissues of the scalp were dissected away, no noteworthy changes were noted. Aside from engorgement of the meningeal veins and a slight increase in fluid beneath the leptomeninges, no gross changes were found in the brain. Microscopic sections of the brain showed cerebral edema with slight cerebral compression. A triangular block of bone was removed from the base of the skull, which revealed a clot of blood within and completely filling the right ethmoid sinus. The sphenoid sinus contained mucus. The right cavernous sinus was next opened and the lining was found roughened and of grayish cast and covered with a purulent exudate. Sections taken from the cavernous sinus showed only one recognizable venous structure, which contained several abscesses consisting of polymorphonuclear cells and endothelial cells. The inflammation extended in to the dense wall of the sinus and in sections stained with kresyl-echt-violet, diplococci were found. Sections of the mucous membranes of the maxillary sinus revealed a considerable loss of the epithelium, with edema and moderate hyperemia of the underlying stroma. The changes in the sphenoid sinuses were similar to those of the maxillary sinus except that the inflammation was milder. Examination of the lungs revealed the presence of multiple bacterial emboli in the pulmonary arteries with the formation of multiple bilateral pulmonary abscesses. A right acute serofibrinous pleuritis with multiple subpleural petechiae and ecchymoses was found. The liver and kidneys showed changes characteristic of focal acute hepatitis and acute toxic nephrosis.

COMMENT

The question arises as to whether the sinus findings are to be considered as etiologic factors in the case. The chain of symptoms which followed the surgical procedure in the mouth seems to indicate a dental rather than a sinus origin. One of the factors to be considered is the rapid drop in temperature following the removal of the oral focus, which might indicate the releasing of a virulent type of infection. Postmortem examination of the tissues of the accessory nasal sinuses did not reveal any changes which would be expected in view of the findings at the time of the operation on the sinuses. The path of the infection is left undetermined as it was impossible to remove the superior maxilla and trace a possible course through the bone. It is possible that the extension may have progressed through venous channels in the alveolar bone and thence to the pterygoid plexus and through the foramen Vesallii to the cavernous sinus.

ACUTE INFECTIONS ORIGINATING IN AND ABOUT THE MOUTH*

By GUY R. HARRISON, D.D.S., Richmond, Va.

THE reaction of the body to local infections bears a direct relationship to the virulence of the infecting organisms, the condition of the parts where the organisms gain entrance and the resistance of the patient. The treatment of local infections should be based to a considerable extent on an effort to increase the patient's resistance. It is often observed that, in the treatment of infections about the mouth, there seems to be a tendency to treat the local lesion and to overlook the importance of treating the patient as a whole. In endeavoring to bring about increased resistance, the treatment of the parts primarily involved becomes of great importance, but the general treatment of the patient should not be neglected.

Patients with infections about the mouth are frequently treated as ambulatory when they are ill enough to be hospitalized. This is probably due to the fact that the mouth has developed a degree of resisance to infection which is remarkable. It should always be remembered that any acute infection in this region may develop into a very serious condition and all such cases should be considered potentially dangerous. Treatment should be promptly started and, as a rule, the patient should be put to bed. If this were done, there would be fewer cases causing anxiety and going on to fatality. The patient would be spared much suffering, with a shortened period of illness, and the development of complications leaving objectionable deformities would often be avoided.

It is amazing how lightly the average person views infections arising about the mouth, and it may be added that many physicians and dentists apparently have the same point of view. Often, patients are treated for acute infections about the mouth in dental offices, when, if the infection were located elsewhere, the patient would demand home or institutional care.

While, as a rule, acute infections developing about the maxillae are not nearly so dangerous as those arising from the mandible, those cases about the maxillae which progress to the point of showing dangerous symptoms do not respond to treatment so well. (Fig. 1.) This is partly explained by the inaccessibility of a deep infection situated, for example, in the zygomatic fossa and the possibility of intracranial involvement. The possible seriousness of an apparently simple infection about the upper lip, and the potential dangers attending even the slightest surgical procedure within the lip in the presence of infection should be generally recognized. The possibility of the infection's traveling through the veins to the intracranial structures constitutes the most dangerous aspect of such a case.

DENTO-ALVEOLAR ABSCESS

The acute dento-alveolar abscess is usu-

*Read before the Section on Oral Surgery and Exodontia at the Midwinter Clinic of the Chicago Dental Society, Jan. 20, 1932.

ally a result of death of the pulp of a tooth followed by infection, the pyogenic organisms gaining access to the periapical tissues by the way of the apical foramen and pus forming in the surrounding structures. Not infrequently, it occurs as a sequel to a long-standing inflammatory lesion. Cases are observed which have arisen from an invisible retained root and about the apices of teeth which have been pulpless for years. Likewise, a chronic inflammatory pericemental or pericoronal condition may be the source.

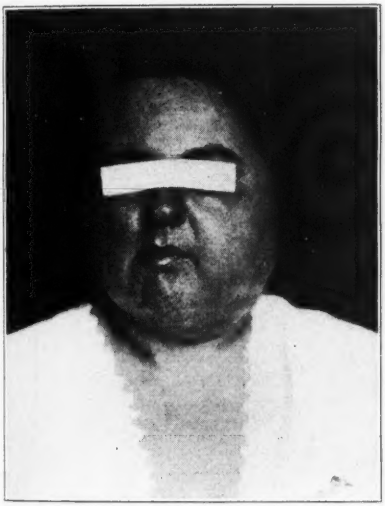

Fig. 1.—Cellulitis arising from vicinity of maxillary third molar. The swelling in the region of the temple is not a good prognostic sign.

DIAGNOSIS

All of the cardinal symptoms of acute inflammation accompany the presence of an acute dento-alveolar abscess and there is present an elevation of temperature. The tooth involved is usually very painful to touch and apparently loose in its socket, and the overlying soft tissues are red and may be edematous in varying degrees. Owing to the fact that the pus in the earlier stages is confined within the bone, or beneath the periosteum, the pain is very severe. The extent and location of the facial swelling will be largely determined by the origin and course of the infection. The pus usually tends to perforate the bone through the outer plate, and thus a fluctuating mass is produced beneath the gum and adjacent soft tissue.

To one clinically acquainted with oral pathologic processes, the diagnosis of acute dento-alveolar abscess, except in certain cases, will not be difficult. There are some conditions in which, when they occur about the mandible, differential diagnosis becomes of great importance. Inflammatory lesions of the salivary glands are seen in which swelling and pain are present, producing symptoms simulating an acute dento-alveolar abscess. This is especially true when there is present a painful enlargement of the submaxillary salivary

Fig. 2.—Stones in duct of submaxillary gland, with extensive inflammatory involvement and infection in floor of mouth. The infection was mistakenly thought to arise from a mandibular molar. The smaller stone could easily be overlooked.

gland with pain in the tongue and swelling and pain in the floor of mouth caused by the presence of a salivary stone blocking the flow of saliva. (Fig. 2.) The patients usually give a history of previous attacks occurring when food is taken, especially food having an acid reaction. The outlet of the duct back of the mandibular incisor teeth may be red, and pus may be seen discharging from it. Ulcerative lesions of the mouth and throat often produce a submaxillary lymphadenitis which may be mistaken for an acute infection of dental origin.

Fig. 3.—Left: Case of acute dento-alveolar abscess. In this type of case, skin incision is indicated, and if it is promptly made, and the involved tooth removed when this is indicated, the disfiguring scars shown in the photograph to the right will be avoided.

TREATMENT

In an acute dento-alveolar abscess, provision for drainage should be made as soon as the presence of pus is suspected. In only a small percentage of cases will satisfactory drainage be obtained through the pulp canal. Most cases can best be treated by an incision promptly made. G. V. Black,[1] in discussing the advantages of early incision in acute alveolar abscess, says:

> The hemorrhage will relieve the congestion and, if a slight amount of pus should have penetrated the bone and reached the periosteum, relief will be secured. If the pus has not yet reached the outer plate of bone, the opening will very likely be found by it within a few hours, and the duration of the pain will thus be cut short. The possibility that the periosteum will be lifted from the bone will be avoided and necrosis will often be prevented. There seems therefore to be every reason for an early incision to and through the periosteum. It would be much better if earlier incision should be occasionally made

1. Black, G. V.: Special Dental Pathology, Chicago: Medico-Dental Publishing Company, 1915, p. 352.

when not absolutely necessary. No harm would be done. My observation of hundreds of cases in which serious complications have occurred as the result of failures to make incisions early, or not at all, leads me to strongly emphasize the desirability of more prompt surgical interference in these cases.

In the early stages, the application to the face of cold saturated solution of magnesium sulphate will aid in making the patient more comfortable. The use of poultices, hot water bottles and heating pads may cause an abscess to drain, or make necessary that it be drained on the face, that otherwise might rupture into or could be drained inside the mouth. Anodynes and hypnotics should be used when necessary to control pain.

Fig. 4.—Mandible in case of osteomyelitis, which developed after removal of first molar and impacted third molar.

The exercise of sound clinical judgment is necessary to determine the advisability of removing a tooth in the presence of an acute infection. This will be referred to again under the discussion of osteomyelitis. When indicated, incisions for drainage on the face should be made early and before there is a breaking down of the subcutaneous fascia, as the resulting scar will be much less conspicuous. (Fig. 3.) Skin incisions should usually be made under nitrous-oxid-oxygen or ethylene anesthesia. Whenever practical, they should be placed in the lines of the skin well beneath the mandible and at the lowest point of the swelling, being carried through the subcutaneous fascia only; after which, blunt exploration of the underlying tissues should be carried out to avoid injury to blood vessels, nerves and other structures. The maintenance of drainage is important, and often the use of rubber drainage material is indicated. When intra-oral drainage has been obtained, the frequent use of hot mouth washes or hot intra-oral irrigations will be helpful.

OSTEOMYELITIS

Osteomyelitis of the maxillae and mandible, in the majority of cases, arises from infection of the teeth and their investing tissues, but not infrequently follows traumatic injuries to the facial bones. It is to be remembered that periostitis, osteitis and osteomyelitis clinically can be considered as different stages of the same disease. Either of the first two may, under favorable conditions, develop into the third.

ETIOLOGY

In the presence of an acute infectious process, surgery of bone many times apparently results in osteomyelitis. This brings up the much discussed question of the extraction of a tooth which is acutely abscessed. There is no doubt that the removal of a tooth in the very early stages of an acute pericemental infection will often abort a more serious condition. On the other hand, if a tooth is removed at a time when there is involvement of the marrow-bearing bone, to any great extent, which must occur early in some cases, the operation is certainly not indicated. In brief, it is my opinion that the extraction of a tooth in the presence of an acute infection, at a time other than the very early stage of an acute pericementitis, may be a dangerous procedure.

A procedure advocated by G. V. Black, which is safer than the extraction of the tooth, is the incision of the soft tissues down to the bone, lifting the periosteum from the bone over a limited area and, if pus has not perforated the bone, making a small opening through the cortex in the region of the root ends of the tooth. Such a simple operation will usually give prompt relief from pain and many times abort a serious bone infection. After the subsidence of the acute symptoms, the tooth usually had better be removed. Swelling in these cases is indicative of invasion of the tissues outside of the bone by the inflammatory products. Removal of the tooth when pus is welling up about it will probably have no perceptible effect on the case. In many cases, even though there be a considerable area of bone bared of its periosteum, prompt and adequate incision will result in complete resolution without extensive bone involvement.

Injudicious curettement of bone following the removal of teeth occupies a prominent rôle in the production of osteomyelitis. (Fig. 4.) This statement should not be construed to mean that the inflammatory new tissue when present about the root end of a tooth should not be gently removed, if left *in situ,* after extraction of the tooth.

Osteomyelitis, just as cellulitis, not infrequently develops after the removal of teeth in the presence of a pericoronal infection, especially when a partly erupted

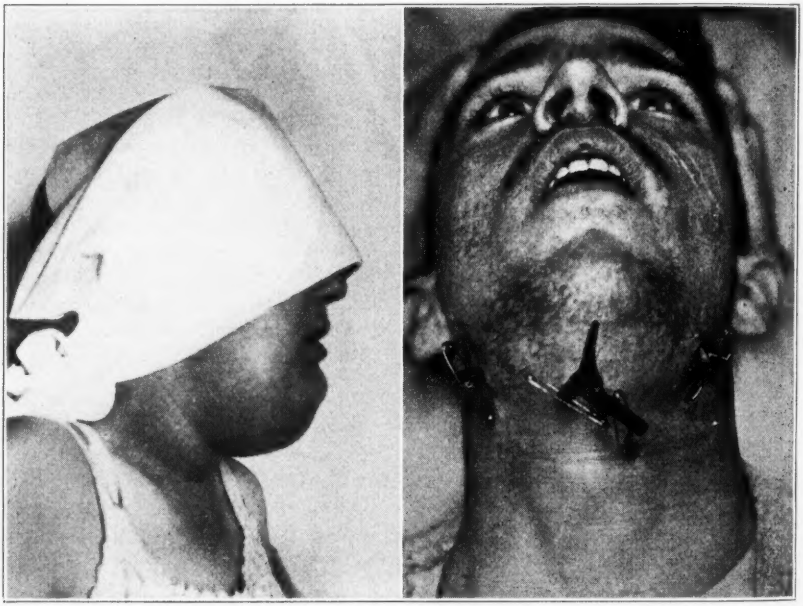

Fig. 5.—Cases of Ludwig's angina. In the case shown at the left, the starting point was in the anterior part of the floor of the mouth. In the case shown at the right, the infection arose from a mandibular right first bicuspid and rapidly spread along the cellular planes of both sides. Location of incisions and drain may be noted.

tooth, such as a third molar, is removed during an acute exacerbation of the chronic infection usually present about such teeth. It is safer, by indicated local treatment, such as hot irrigations intraorally and the instillation of iodin solutions beneath the flap of soft tissue about the tooth, together with the applications of moist heat externally, to bring the infection under control before any surgical work is done in the involved area. Either osteomyelitis or cellulitis, or both, may develop without operation, from periapical or pericemental infection or infection about partly erupted teeth.

TREATMENT

The treatment of osteomyelitis can be summed up as follows: (1) early and adequate drainage, which should be maintained with the minimum amount of tissue injury possible; (2) frequent cleansing by gentle irrigation; (3) removal of sequestrums when they are formed and sufficient new bone has been produced to maintain continuity; (4) general supportive and eliminative treatment. In order to avoid the occurrence of a pathologic fracture, intermaxillary fixation is sometimes indicated. Periodic roentgenray examination during the course of the disease gives valuable information. In connection with the treatment of osteomyelitis, Blair and Brown[2] state:

> The literature still shows the old division between those who advocate early conservatism versus those who promise to abort the disease by the earliest possible radical surgery. The position of the latter, who are still in the minority, is supported by neither new arguments nor any adequate number of convincing case reports.

CELLULITIS

Any infection arising about the mouth may produce an acute diffuse cellulitis of the adjacent and nearby tissue planes, by direct extension. The clinical findings will be largely influenced by the origin of the infection and the fascial planes involved, making necessary at times differential diagnoses.

ETIOLOGY

Cases are seen which have developed from infection of the teeth, their investing tissues and new growths, injuries and fractures, following extraction of teeth, hypodermic injections, osteomyelitis, infections of the salivary glands, with and without the presence of stones, and other conditions.

In a cellulitis about the face, when trismus is present to any marked extent, it will be found that the infection nearly always arises primarily from the dental tissues. Rarely, if ever, is a submaxillary cellulitis of tonsillar origin. Ivy[3] states:

> It is not denied that acute submaxillary lymphadenitis can exist, but very seldom as a complication of acute dento-alveolar infection. Lymphadenitis in this region is nearly always due to ulcerations of the oral soft tissues, the gums, vestibule and floor of the mouth and tongue. In tonsillitis and inflammations about the fauces the lymp-node beneath the angle of the jaw is involved. These lymphatic swellings are almost never accompanied by trismus. . . . It is quite the rule for a tonsillar infection to be accompanied by a lymph-node enlargement, the tonsillar node being situated rather at the angle of the mandible, than in the submaxillary triangle itself. Acute inflammation of the gums and other soft tissues of the mouth, as in Vincent's gingivitis, are also characterized by lymph-node enlargement, this time in the submaxillary and submental region. But it has been shown that an entirely different picture characterizes the swelling from infection arising in the teeth and mandible itself. Here we have direct extension of the inflammation to the submaxillary soft tissues from a periostitis, with marked trismus.

2. Blair, V. P., and Brown, J. B.: Course and Treatment of Simple Osteomyelitis of Jaws, Internat. J. Orthodon., 12:52 (Jan.) 1926.

3. Ivy, R. H.: Swellings of Submaxillary Region, Ann. Surg., 81:605 (March) 1925.

PROGNOSIS

The prognosis in acute infections involving the tissue planes about the mouth is always serious and often grave. Therefore, the treatment should be prompt in order to avoid spreading and the development of dangerous symptoms. In most cases, the prognosis will vary in direct proportion to the promptness with which correct diagnosis is made and proper treatment instituted.

TREATMENT

Treatment is surgical procedure based upon an accurate anatomic knowledge of the structures in the involved area. While certain of these cases may be aborted by rest and general elimination, together with the application of ice packs externally, in well-developed cases surgery should not be delayed if the patient does not begin to improve within from twenty-four to forty-eight hours. In those cases involving the tissues about the maxillae and upper part of the face, intra-oral drainage will often suffice. In involvement of the lower part of the face, the sublingual or the submaxillary structures, skin incisions are usually indicated. Intra-oral incision alone should be made when there is involvement of the superficial tissues of the mouth only, and even then skin incisions at times are indicated to protect the deeper structures.

It is believed that skin incisions properly placed need not be so long as is sometimes advocated and should follow the natural lines of the skin with the avoidance of important anatomic structures, when this is practical. Incisions carried through the superficial fascia will permit of blunt dissection and exploration of the deep fascial planes. Simple incisions are usually useless. It is necessary to obtain and maintain separation of the tissue planes by use of rubber drainage materials. While the use of tubing tends to make an uglier scar than the use of rubber tissue, it should usually be employed when carried deep, as it will make more space between the tissue planes. Through and through drainage from one skin incision to another is often indicated.

In the presence of an acute inflammatory condition, the application of drugs, such as iodin, mercurochrome and sulphonated bitumen (ichthyol) to the mucous membrane or skin, as well as any manipulation such as rubbing of drugs over the involved parts, has no value, and in certain cases is contraindicated. The application of heat externally in a well-developed case of acute cellulitis, without signs of beginning localization, unless provision for drainage has been made, should not be made. Hot intra-oral irrigations are very helpful, and moist heat externally after provision for drainage has been made aids in promoting the breaking down and drainage of the involved parts. In the foregoing reference to the use of heat externally applied, exception may be made in those cases in which the tissues about the ramus of the mandible alone are involved.

In addition to the surgical procedure advised, repeated small doses of atropin will, by drying up the oral secretions, make the patient much more comfortable and possibly make less probable the development of pneumonia. A certain percentage of patients apparently develop pneumonia by aspiration of septic material. When tracheotomy is considered necessary, it is believed that, if possible, laryngeal intubation of short duration is preferable. All supportive and eliminative measures should be used and the fluid intake should be carried to the maximum. Owing to the strain on the heart, its action should be carefully watched and, when indicated, a preparation of digitalis

should be administered. Small doses of morphin are a valuable adjunct, serving to relieve the patient of pain and to allay restlessness and anxiety, but caution should be exercised in its use.

The use of serums and vaccines as well as the intravenous administration of drugs apparently does little or no good in well-developed cases. Roentgen-ray therapy has a useful place in the treatment of cellulitis about the face and neck, but, in most of the acute cases, the condition of the patient is so alarming that the surgeon dares not delay for the period of time necessary to obtain the desired effect. It is very valuable in cases of some duration involving the structures about the ramus of the mandible. The roentgenologist should demand of the surgeon careful observation of the case and a sharing of the responsibility. A sudden and dangerous edema of the larynx may follow roentgen-ray treatment.

LUDWIG'S ANGINA

A type of cellulitis starting in the floor of the mouth and submaxillary regions which is characterized by its rapid spread and fixation of the involved parts into a hard boardlike mass is known as "Ludwig's angina." (Fig. 5.) This type of cellulitis most often has its origin in infection about the dental structures, and, while not so frequent, occurs sufficiently often to be of great clinical interest as it is credited with a mortality rate of from 40 to 50 per cent. It is believed that this high mortality rate will be influenced by recognition of the dangers of the condition, accompanied by prompt and adequate surgical and supportive treatment.

ETIOLOGY

Ivy[3] quotes Sebileau in reference to the development of an acute diffuse cellulitis of the submaxillary region from a dental abscess in the mandible as follows:

> The abscess is at first intra-alveolar, then intra-osseous; it then becomes subperiosteal, and finally extraperiosteal, provoking around it a more or less extensive cellulitis, which resembles lymphadenitis. If the perforation takes place at the level of the alveolar process of the jaw, there is formed a swelling in the vestibule of the mouth with a buccal opening or an opening on the skin of the face; if, on the contrary, the perforation occurs at the level of the body of the bone, a true submaxillary phlegmon is formed.

DIAGNOSIS

The onset of acute cellulitis about the floor of the mouth is nearly always rather sudden, although the acute condition is often preceded by a chronic inflammatory condition of long standing. When seen early, these patients do not appear to be very ill, which may mislead those not familiar with such cases. The temperature will vary from 99 to 103 F. or slightly higher. There is a moderate leukocytosis, usually not above 15,000. The differential count will probably show a high percentage of polymorphonuclear cells.

The mucous membrance of the floor of the mouth is very red, edematous to a marked extent and covered with a grayish slough. The tongue is pushed upward toward the roof of the mouth and backward toward the pharynx. Dysphagia, dysphonia and dyspnea are present in varying degrees. The enlargement manifests itself as a very hard mass without skin involvement other than its tenseness. Pressure over the area of enlargement reveals a very marked tenderness without points of fluctuation.

There is usually a drooling of saliva. The edema may involve the glottis and epiglottis and produce sudden death. If the area of the large vessels of the neck is involved, cyanosis of the face may be

present. Owing to obstruction of the respiration, the patient is more comfortable when sitting up and should not be placed flat on the back. Altogether, these patients present a pitiful picture.

TREATMENT

In the treatment of this serious condition, dependence must be placed mainly on surgery consisting of exploration of the involved tissue planes for the relief of tension and drainage. The indicated operative procedure should be carried out as follows: a pair of curved, blunt hemostatic forceps is placed in a vertical submental incision running from beneath the symphysis of the mandible to the area over the hyoid bone and carried through the deep fascia. It is then carried beneath the anterior belly of the digastric muscle, backward to the area about the submaxillary salivary gland; with exploration of this area. The forceps are carried outward toward the skin over the gland. Another incision made over the points of the forceps will permit the points to be brought to the surface, and a length of rubber tubing can then be grasped in the forceps, the withdrawal of which will carry the drain through the dissected tract. (Fig. 5, right.)

Exploration of the tissues above the mylohyoid muscle, which is important, can be accomplished through the submental incision by a division of this muscle along the course of its fibers. The mucous membrane of the mouth should not be perforated. It is believed that there is always present in these cases a suppurating focus or suppurating foci. The duration of the disease is a factor in demonstrating its presence. Incision and provision for drainage are indicated whether or not pus is found, in order to lessen tension and permit the escape of toxic material. A knowledge of the anatomy of the structures shows how easily a small area of suppuration can be overlooked.

ANESTHESIA

The selection of the anesthetic agent when the floor of the mouth is involved to any great degree, is indeed a problem. Ether is contraindicated owing to the congestion already present, the danger of an edema about the larynx, the increased mucous secretion produced by the drug and the difficulty of maintaining a light anesthesia with it. The presence of trismus and the resulting difficulty in gaining access to the respiratory tract in many cases make the administration of any general anesthetic hazardous.

The condition of the tissues and the depth of the exploration necessary constitute a serious handicap to the use of local anesthesia. Aside from the bad features of injecting fluid into tissues already very edematous, it is difficult to obtain satisfactory anethesia, and it is not well to subject the patient to the shock produced by the pain of having highly innervated inflamed structures handled. Despite these objections, local anesthesia should be used in most cases.

Where there is not extensive involvement of the floor of the mouth, the anesthetic agent of choice seems to be a very light nitrous oxid and oxygen or ethylene preceded by the hypodermic administration of morphin sulphate one-quarter grain and atropin sulphate one-hundredth grain, three-quarters of an hour prior to the operation. Fifteen minutes before the operation is to begin, an additional dose of morphin may be given.

In many cases, if possible, a rubber block should be placed between the teeth, and under local anesthesia, a suture, through the tip of the tongue, prior to starting anesthesia, so that, if it becomes necessary, access may be had to the air

passages. If the patient becomes even slightly cyanotic, the administration of the anesthetic should be stopped at once. If the cyanosis is found to be due to obstruction of respiration, which cannot be promptly corrected, tracheotomy should be performed without hesitation, as this offers the only hope of saving the patient's life. During the anesthesia, the fact that there is a possibility of rupture of an abscess into the mouth or pharynx must not be lost sight of.

SUMMARY

Acute infections involving the tissue planes about the mouth and jaws, especially those involving the floor of mouth and submaxillary triangle, are of too serious import to be approached in the casual manner often adopted. The prognosis is always potentially serious, often grave, and, not infrequently, there is a fatal termination.

Consultation often increases the chances for a good result, and the consultants share the responsibility when the outcome is bad.

The fundamental requirement for effective management is the prompt establishment of thorough surgical drainage, carefully planned with reference to the anatomic relationship of the structures involved. The selection of the anesthetic is a matter of extreme importance.

The juxtaposition of the inflammatory mass to the respiratory passageway in many instances must be kept constantly in mind during any surgical procedure and the surgeon must be prepared, at an instant's notice, to perform a tracheotomy as a life-saving procedure.

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BONE CHANGES INCIDENT TO ORTHODONTIC TOOTH MOVEMENT IN MAN*

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ALL experiments involving orthodontic tooth movement here reported were carried out primarily with the idea of determining what changes occurred in the involved bone and soft tissues of the experimental animals used and the possible application of these changes to man. Previous to the time that histologic studies were made of such material, certain theories were in vogue, viz., the pressure theory of Schwalbe-Flouren and the theory of Kingsley and Walkhoff. The former held that during orthodontic tooth movement, resorption occurred on that portion of the bone where pressure was applied and deposition on the side where pressure was presumed to have been eliminated; while the latter made the elasticity, compressibility and extensibility of the bone responsible for the orthodontic tooth movement.

The research on experimental animals made by A. Oppenheim of Vienna revolutionized these theories. Other workers

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*Read before the Section on Research and Biologic Sciences at the Midwinter Clinic of the Chicago Dental Society, Jan. 20, 1932.

along the same lines were A. Leroy Johnson, J. L. T. Appleton, Jr., and L. S. Rittershofer of Philadelphia, John A. Marshall of San Francisco and Carl Breitner of Vienna.

Oppenheim[1] carried out his experiments on baboons, using the labial arch and wire ligatures to obtain movement, and, after a period of forty days of force application, labiolingual sections were made through the jaws parallel to the long axis of the tooth. Various movements were obtained, viz., tipping (labial and lingual), elongation and depression. In every instance, there was a general rearrangement of the architectural structure of the bone, the bony spicules becoming oriented in the direction of the force or stress.

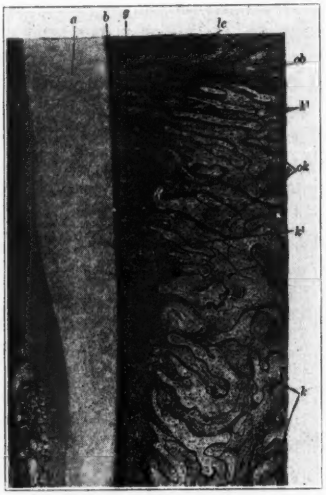

Fig. 1.—Effect of labial movement (lingual side). The bony spicules in the third near the alveolar border present long spicules with orientation vertically to the long axis of the tooth (k^1), densely beset with osteoblasts (*ob*). *a*, dentin; *b*, cementum; *g*, peridental membrane; *lc*, dental ligament; *k*, old bone; *ok*, osteoclasts. (Oppenheim.)

Johnson, Appleton and Rittershofer,[2] at a later date, carried out similar experiments, using lingual springs on a smaller animal, the macacus rhesus monkey, and reported results not unlike those of Oppenheim.

John A. Marshall,[3] also working with the macacus rhesus and using a spring to separate the maxillary central incisors, produced a fracture of the alveolar process without obtaining bone changes as found by other investigators. While this particular work of Marshall is significant in cautioning against excessive force, his results have no direct bearing on the subject; for we feel that no such relatively powerful force should be applied in human orthodontic therapy. It should be explained that Marshall was concerned with the problem of root resorption under mechanical orthodontic stimuli and his work is referred to because an orthodontic appliance was used to obtain tooth movement.

Carl Breitner,[4] in a rather extensive report published in three parts, propounds some interesting findings. His experimental animal is the macacus rhesus and his mechanism the so-called *en bloc* fixation, wherein caps for all the teeth in the buccal segment are cast in one piece and labial arches used for the stabilization of

1. Oppenheim, A.: Tissue Changes Particularly of Bone Incident to Tooth Movement, Am. Orthodontist, 3 (Oct.) 1911; (Jan.) 1912.

2. Johnson, A. L.; Appleton, J. L. T., Jr., and Rittershofer, L. S.: Tissue Changes Involved in Tooth Movement, Internat. J. Orthodon., 12:889 (Oct.) 1926.

3. Marshall, J. A.: Studies in Apical Absorption of Permanent Teeth, Internat. J. Orthodon., 16:1 (Jan.) 1930.

4. Breitner, Carl: Experimentelle Veränderung der Mesiodistalen Beziehunger der obern und unteren Zahnreihen, Ztschr. f. Stomatol, 28:134 (Feb.), 620 (July) 1930; 29:343 (April) 1931.

the anterior teeth. Hooks are strategically placed for the reception of light intermaxillary rubber bands; in one instance, for the production of a Class III (Angle) and in another experiment for the creation of a Class II (Angle) case. With this apparatus used for moving the mandibular arch mesially, over a period of eighty days, bone changes were obtained showing resorption on the distal sides of the interalveolar septums of the lower teeth and apposition on the mesial sides with the newly formed bony spicules arranged in the direction of the mesial stress modified somewhat by the apical stress of the raised caps. In the experiment arranged for reverse movement, like changes occurred except that the areas of resorption and apposition changed positions.

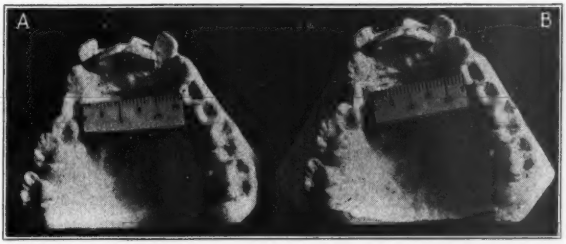

Fig. 2.—Left: Model before lingual movement of upper right first bicuspid. Right: Model after lingual movement of upper right first bicuspid, showing extent of movement to be 2 mm.

In summarizing his findings, Breitner states:

> Intermaxillary rubber bands cause a change of occlusion; (a) by an immediate movement of all the teeth on which the force acts; (b) by changing the form of the mandible (enlargement or reduction) due to an osseous change in the ramus, angle of the mandible and the condyloid process of the mandible, and (c) by a displacement of the mandible in relation to the cranium due to a migration of the articular fossa.

It seems appropriate at this time to enter into a discussion of the histologic picture of resorption and apposition of bone without going into the detailed mechanism of the processes. Quoting from Oppenheim's above mentioned paper:

> As it is well known, the bone is built by cells, the so-called osteoblasts; as in the manner of the cells, be it through the transformation of their protoplasm (Waldeyer) be it through a sort of secretion (Gegenbauer), a question which up to the present has not yet been satisfactorily settled, they build the young bone substance. This young bone substance is not as yet calcified, the deposition of the calcium salts taking place at a later period. The growing bone during its further progress encloses a part of the osteoblasts, through which event the so-called bone corpuscles originate. The indications of new bone formation are, therefore, a kind of epithelial-like covering of osteoblasts arranged in rows and uncalcified bone substance (osteoid tissue) which surrounds the older bone in the form of a zone. The indications of resorption on the histologic slide are large polynucleated cells, giant cells, (osteoclasts, Kölliker) imbedded in bays or recesses of the bone. These recesses, Howship's lacunae, are the results of the activity of the cells.

In addition, it may be stated that mononuclear osteoclasts may be found in the area of bone resorption.

Figure 1, taken from Oppenheim's pa-

per, illustrates this histologic picture. *ob* is the covering of osteoblasts, arranged in rows; *k'*, newly oriented bony spicules, while osteoclasts are to be found at *ok*, imbedded in recesses of the bone (Howship's lacunae).

Apparently all writers[5] agree on this histologic picture of resorption and apposition of bone not only as related to orthodontic tooth movement, but also under all varying conditions of bone growth, resorption and apposition.[6]

Fig. 3.—Buccolingual section through upper right first bicuspid, which was moved lingually for seventy days with rubber bands in case of girl, aged 18. *AP*, buccal alveolar process removed attached to the tooth. Higher magnifications of areas *X* and *Y* are shown in Figures 4 and 10.

In their work, both Oppenheim and Breitner assumed that their findings were applicable to man, but had no factual data upon which this assumption was based. Thus, Oppenheim states that the regulating appliances "produce effects in the bones and in the other tissues, which during regulating in man must be similar under like established conditions."

Breitner, too, in the second portion of his paper, expounds suppositions along the same line. He says:

> There is no doubt that the teeth and jaws can be moved in animals the same way as in man. Also, there is no doubt that the effect of the employed force on the bones is analogous to that in man. Only the intensity of the action is questionable; i.e., it is doubtful whether the same force can cause changes of the same degree in the human and animal teeth and bones or whether the effect is quantitatively different. Further, there may exist doubt as to whether we are able to use at least analogous forces.

It has long been known that facts established by animal experimentation are not necessarily applicable to or to be duplicated in man, but further work on man himself is simplified by such work. Then, too, the experiments on man establish the significance of the animal experiment as applied to the human species. Stallard,[7] in his criticisms of Oppenheim's work, notes that animals did not have malocclusion, and that, therefore, the reaction of their bones might well be different from reaction of bones accom-

5. Macewen, William: Growth of Bone, Glasgow: James Maclehose & Sons, 1912.

6. Leriche, R., and Policard, A.: Normal and Pathological Physiology of Bone; trans. by Moore, Sherwood, and Key, J. A., St. Louis: C. V. Mosby Co., 1928.

6. Key, J. A.: Factors in the Atrophy of Bone, J. A. D. A., 17: 1660-1669 (Sept.) 1930.

7. Stallard, Harvey: Criticism of Oppenheim 1911 Report, Internat. J. Orthodon., 14:872-876 (Oct.) 1928.

panying human malocclusion. Thus, he reasons, Oppenheim's work differed fundamentally from human orthodontic therapy.

We undertook to work along the lines of carrying out further experimentation on man himself, as suggested by Albert H. Ketcham,[8] in a paper on "Apical Root Resorption of Vital Permanent Teeth," in order that we might find what actually occurred, histologically, in the supporting structure of the teeth moved by orthodontic methods, and how those findings compared with those obtained when experimental animals were used.

The nature of the experiment required material difficult to secure. It was first necessary to find orthodontic cases, the diagnosis of which would call for the removal of two teeth in the course of treatment, preferably one on each side of the same arch. Such a patient, a girl aged 18, in good health, was found after much search.

Fig. 4.—Higher magnification of alveolar margin, buccal side, of moved tooth (area *X*, Fig. 3). *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *AB*, alveolar bone; *OB*, osteoblasts; *R*, resorption on outer surface of alveolar process.

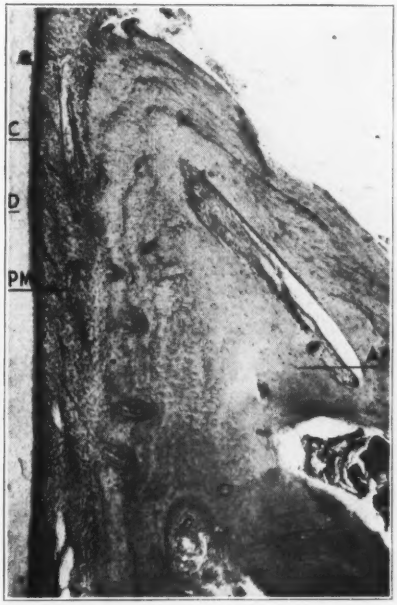

Fig. 5.—Buccolingual section of alveolar margin on buccal side of control tooth (upper left first bicuspid of patient referred to in Figure 3). *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *AB*, alveolar bone. The even outline between the periodontal membrane and the alveolar bone may be noted.

Before active orthodontic treatment was started, an appliance was constructed for the lingual movement of the upper right first bicuspid. The lower right first

8. Ketcham, A. H.: Progress Report of Apical Root Resorption of Vital Permanent Teeth., Internat. J. Orthodon., 15:328 (April) 1929.

molar and first and second bicuspids were banded, the bands soldered together and a lingual hook turned apically soldered to these bands to provide for the application of direct intermaxillary force. The tooth to be moved, the upper right first bicuspid, also was banded and a hook soldered on the buccal surface to engage the rubber band from below and thus cause a lingual tipping of the upper first bicuspid. The rubber bands were worn continuously by the patient for a period of seventy days, at the end of which time the maxillary right first bicuspid with the surrounding bony structure was removed intact. The corresponding tooth on the opposite side was removed one week later in the same manner and used as the control specimen. These teeth were removed under a local anesthetic by cutting through the bone with a tapered fissure bur 701, great care being taken not to disturb the gingival tissues of the adjacent teeth. Active orthodontic treatment with another appliance was then instituted, time being allowed for the healing of the sockets.

Fig. 6.—Higher magnification of Figure 4. *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *OB*, osteoblasts; *O*, light seam of osteoid (newly formed, still uncalcified bone) bordering periodontal membrane; *R*, lacunar resorption of alveolar bone on outer side of alveolar process.

In Figure 2, photographs of the upper

cast of the patient from which the specimen was taken, the case before movement is shown on the left. The measurement between the tips of the lingual cusps of the upper first bicuspids is 27 mm. On the right, the appearance of the arch after the movement of the upper right first bicuspids is shown. The distance between the tips of the lingual cusps after movement is 25 mm.; approximately 2 mm. being the amount of movement of the tip of the lingual cusp of the upper right first bicuspid.

It is not within the province of this paper to discuss the propriety of the surgery involved or the judgment used in the orthodontic diagnosis in the foregoing instance. This may be censured by some and approved by others.[9] Suffice it to say that apparently the patient suffered no ill effects and is showing marked improvement in both facial outline and tooth alinement. The experimental moving of the teeth preceding their removal was done with the consent of the patient and her family.

Fig. 7.—High power photograph of bone bordering the periodontal space, situated slightly more toward apex than area in Figure 6. *D,* dentin; *C,* cementum; *PM,* periodontal membrane; *OB,* osteoblasts; *O,* osteoid tissue; *R,* lacunar resorption of alveolar bone on outer side of alveolar process; *OK,* osteoclasts; *BL,* border line between "old bone" and newly formed bone toward periodontal membrane space.

9. Case, C. S.: D. Orthopedia, Chicago: C. S. Case Co., 1908, pp. 116-174. Simon, P. W.: Fundamental Principles of Systematic Diagnosis of Dental Anomalies, trans. by B. C. Lischer, Boston: Stratford Co., 1926.

The teeth thus removed with the surrounding bony structure were immediately placed in formalin and, after decalcification in 5 per cent nitric acid, the specimens were imbedded in celloidin, and then cut in serial sections in a buccolingual direction parallel to the direction of the orthodontic force applied. The specimens were stained with hematoxylin and eosin.

sue was obtained, and that badly mutilated. Microscopically, on this side, there is evidence of bone resorption; but the indications were not definite enough to justify publication or the drawing of conclusions. Therefore, the description is restricted to the side of pull (buccal), from which adequate material was obtained. In considering Figure 4, which is a higher magnification of the alveolar

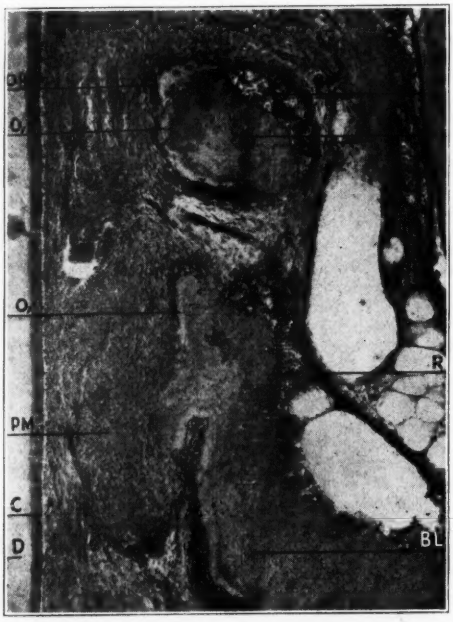

Fig. 8.—High power photomicrograph of area bordering periodontal membrane at slightly different level than in Figure 7. *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *OB*, osteoblasts; O_1, osteoid tissue bordering periodontal membrane; O_2 osteoid tissue bordering marrow space; *R*, resorption on the side of bone trabeculae away from tooth; *BL*, border line between "old bone" and newly formed bone toward periodontal membrane. The similarity of changes in Figure 1 (Oppenheim) in the monkey and those in Figure 8 in the human being may be noted.

Study of Figure 3 would indicate that practically all of the tissue obtainable was on the buccal plate. On the lingual side, because of technical difficulties, little tis-

margin at *x* in Figure 3, we find that the alveolar bone, *AB*, is arranged in spicules at right angles to the long axis of the tooth, parallel to the direction of pull.

This arrangement becomes very evident when compared with the bone structure of the control specimen (Fig. 5), which is shown in the same magnification as the above and on the buccal side of the alveolar margin. In Figure 5, the periodontal membrane is bordered by a straight, smooth outline of bone, showing neither resorption nor apposition. The periodontal space is of a generally uniform width. The outer surface of the alveolar margin of the control tooth, too, has a fairly even outline without evidence of resorption or apposition, which indicates that this tooth was in normal function without excessive stress in any direction. The width of the periodontal membrane in the moved tooth is approximately one and one-half times that of the control tooth, if measured at points closest to the cementum on the side of pull. The bays in the bone between the finger-like projections correspond to the intermissions between the bundles of principal fibers; the location of the bone projections corresponds to the principal fiber bundles along which bone grows. (Orban.[10])

Figure 6 is a higher magnification of the alveolar margin in Figure 4. The spicules of bone are oriented at right angles to the long axis of the tooth and,

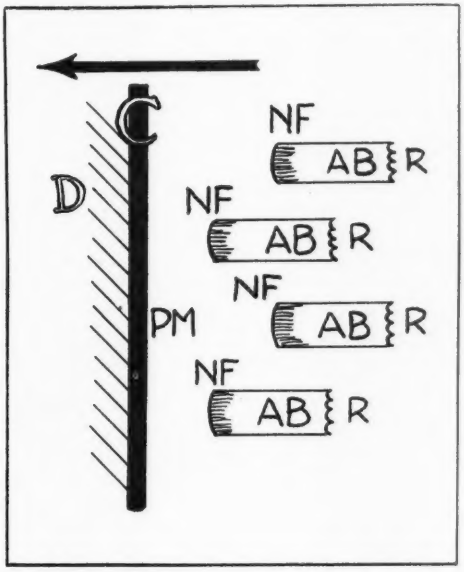

Fig. 9.—Diagrammatic drawing depicting process of resorption and apposition in individual bone spicules. The arrow indicates the direction of pull. *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *AB*, alveolar bone; *NF*, new bone formation; *R*, resorption. Each spicule ("unit") of bone shows apposition on the end toward the tooth and resorption on the opposite end.

10. Orbán, Bálint: Contribution to Knowledge of Physiologic Changes in Periodontal Membrane, J. A. D. A., 16:405 (March) 1929.

therefore, arranged in the direction of the pull. On the outer side of the alveolus, resorption can be illustrated over its entire length. A seam of osteoid tissue (newly formed uncalcified bone) is apparent, adjacent to the periodontal membrane. The older bone with its lamellated structure may be distinguished from the newer calcified bone by a difference in shading.

Figure 7 is a high magnification of the bone lining the periodontal space on the side of pull. The spicules of newly built bone are arranged in the direction of pull, while the old bone retains its original architecture, especially with reference to

Fig. 10.—Area *Y* of Figure 3, showing area toward apex. *D*, dentin; *C*, cementum; *PM*, periodontal membrane; *AB*, alveolar bone. The delicate bone trabeculae bordering the periodontal membrane may be noted.

Fig. 11.—Area corresponding to that in Fig. 10 cut from control tooth. *D*, dentin; *C*, cementum; *PM*, periodontal membrane; AB, alveolar bone. The even outline and width of the periodontal membrane and the even outline of the bone bordering the periodontal membrane may be noted.

the arrangement of the bone lamellae which run parallel to the long axis of the tooth. At *R* and *OC,* resorption is taking place in the old bone on the side away from the tooth; while at *OB,* deposition is in progress on the side toward the tooth.

Figure 8 is another high magnification of the alveolar bone adjacent to the periodontal membrane. In the upper part of the illustration, there is an island of bone, a spicule, or, let us say, a "unit" of bone. This unit shows a number of the characteristics of the process initiated by orthodontic therapy. Thus, there is at *OB,* next to the periodontal membrane, a row of osteoblasts encircling a seam or zone of osteoid tissue, *O'*. Adjacent to this osteoid tissue is newly formed calcified bone separated from the older bone by a definite line of demarcation, *BL,* running parallel to the tooth surface. On the side away from the tooth, at *R,* there is distinct lacunar resorption and the attendant osteoclasts. In the upper right corner of the photomicrograph is an area of old bone bordered by a seam of osteoid on its surface facing the tooth. Below, there is another spicule of bone, next to the periodontal membrane, showing an identical distribution of resorption and new formation. This entire field, therefore, represents several small units of bone in which the areas of resorption and apposition are distributed analogously, and this distribution is found throughout the affected alveolar process in its various planes and depths. This arrangement was first shown by Oppenheim, as previously illustrated in Figure 1 and is illustrated diagrammatically in Figure 9.

In Figures 10 and 11, identical areas near the apex of the moved tooth and the control tooth are shown for comparison. In the moved tooth (Fig. 10), delicate bone spicules line the periodontal membrane. This newly formed bone is arranged in the general direction of the fiber bundles of the periodontal membrane in this region. Figure 11 shows the corresponding area from the control tooth. The arrangement of the bone is the same as that in Figure 5; i.e., there is a solid plate of bone parallel to the long axis of the tooth, with no discernable process of resorption and apposition and a relatively even periodontal width throughout.

SUMMARY

1. Knowledge of microscopic changes in orthodontic tooth movement up to this time have been dependent on animal experimentation.

2. Human tissue material was procured for this study. An upper right first bicuspid of a girl, aged 18, was moved lingually for seventy days. The upper left first bicuspid was used as a control.

3. Both teeth were removed, together with the buccal alveolar process, and sectioned in a buccolingual direction.

4. In the moved tooth, spicules of bone are found on the side of pull, arranged parallel to the direction of force. Each spicule shows apposition of bone on the side facing the moved tooth and resorption on the opposite side.

5. No such changes are found in the control tooth.

6. These changes are similar to those found in monkeys the teeth of which have been moved orthodontically, as described by Oppenheim and others.

7. On the basis of the material obtained, it can be concluded that the reaction of human alveolar bone under orthodontic therapy is quite like that of alveolar bone of experimental animals. The bony spicules become oriented in the direction of the force as they do in the experimental animals.

8. On the basis of the findings, it

might be concluded that further work on experimental animals in obtaining orthodontic tooth movement would be justified and with the feeling that like results would be obtained in the human under similar conditions. This type of investigation on man should be encouraged.

DENTAL CARE OF MIDSHIPMEN AT THE UNITED STATES NAVAL ACADEMY*

By RONALD BARBER,† D.D.S.

IN an article on dental economics published in THE JOURNAL early this year, a statement was made to the effect that an ideal practice would be one in which fees could be left out of consideration. Some members of the profession might suggest additional features which would contribute toward making the practice nearly all that could be desired. For example, it would be highly desirable to have a selected clientele; to have all patients available for call as often as thought necessary; to have reasonable control over the patients, so that one's best professional judgment would govern in the treatment of the case rather than the judgment or whim of the patient, and to have available facilities adequate for the rendering of treatment as indicated, to the end that regular and complete care of all the patients could be assured. It may be that such conditions are not uncommon in the practice of the civilian members of the profession. Whether that is so or not, a description of such a practice may be of some interest.

I have been requested to describe the dental care of midshipmen at the United States Naval Academy. Before I go directly into the subject, a few words may be said about the Academy. To the country at large, the United States Naval Academy is popularly and affectionately known as "Annapolis," just as the United States Military Academy is known as "West Point." In both cases, the schools have been so closely associated with their locations as to make the names of the places synonymous with the institutions. Possibly the Military Academy is as well esteemed by the populace at large as is the Naval Academy, or it may be that there is a glamour to the sea-going branch which gives it special interest. Be that as it may, the constant stream of visitors at the Naval Academy shows that the people consider it one of our great and interesting national institutions.

The Naval Academy is situated at Annapolis, Md., on the shore of Chesapeake Bay at the mouth of the Severn River; a town of about 11,000 population, 31 miles from Washington, D. C., and 29 miles from Baltimore. With its magnificent white stone buildings and profusion of trees set on wide-spreading grounds on the bank of the beautiful Severn, the Academy is an inspiring sight.

Whether one believes in preparedness for national defense or in complete disarmament, he must be a lethargic person

*Read before the Seattle District Dental Society, Dec. 1, 1931.

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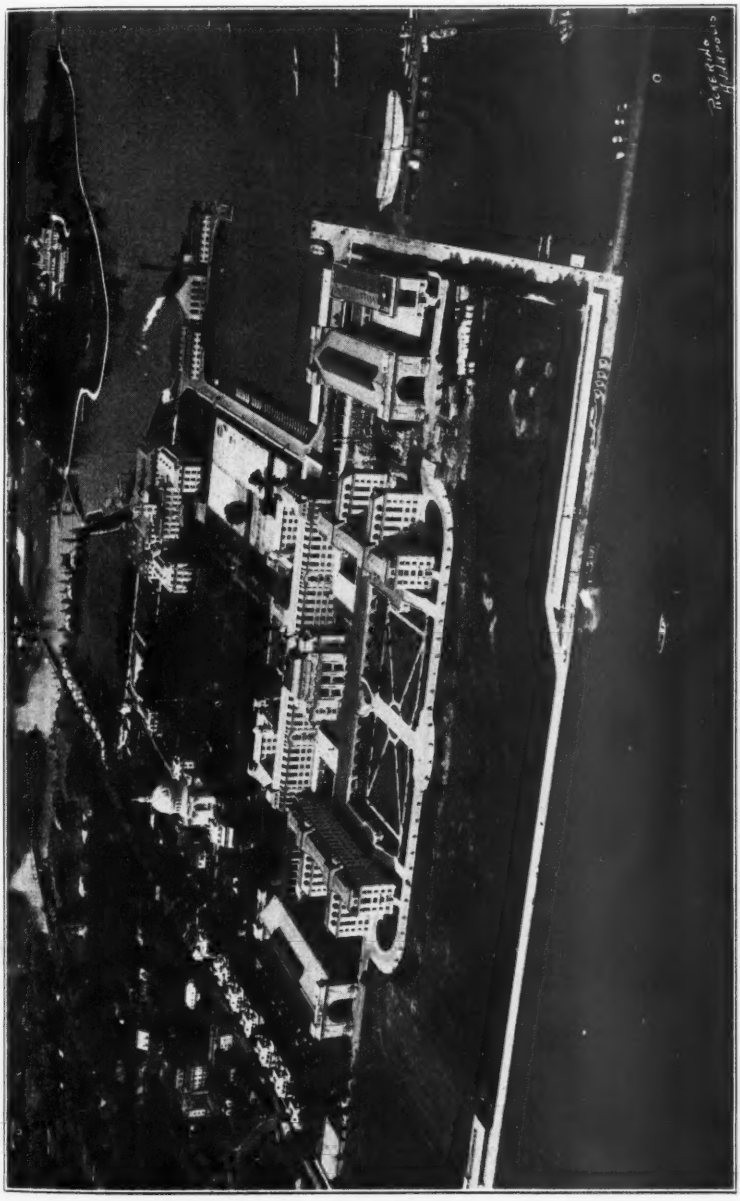

Fig. 1.—United States Naval Academy.

who can visit the Naval Academy and not be stirred by seeing bright-faced young midshipmen marching briskly to and from classes to the rattle of a snaredrum; at boat drill with cutters under oars or other small boats under sails; going through maneuvers with a fleet of submarine chasers, engaging in infantry drill and, in the recreation period, swarming over the athletic fields in a dozen different sports. Church parade on Sunday attracts countless numbers of visitors. Then, the midshipmen in their dress uniforms, led by the midshipman regimental commander,

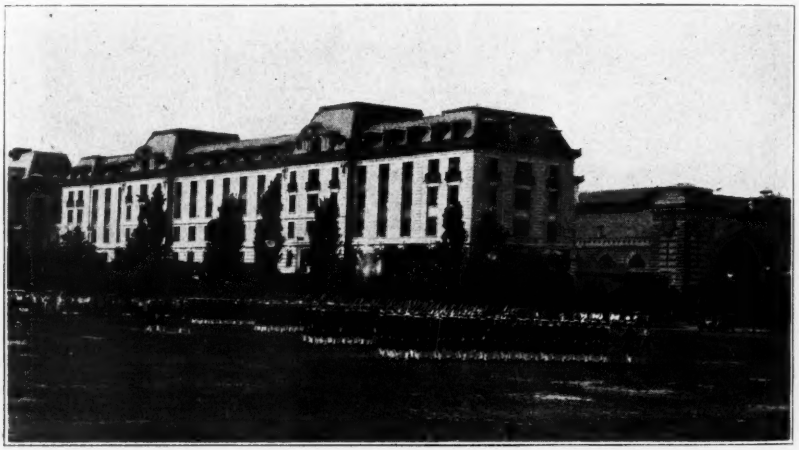

Fig. 2.—Infantry drill.

make an impressive showing as they march to chapel to the music of their own drum and bugle corps.

The purpose of the Naval Academy has been admirably set forth as follows:

THE MISSION

To mold the material received into educated gentlemen, thoroughly indoctrinated with honor, uprightness, and truth, with practical rather than academic minds, with thorough loyalty to country, with a groundwork of educational fundamentals upon which experience afloat may build the finished naval officer, capable of upholding, whenever and wherever may be necessary, the honor of the United States; and withal giving due consideration that healthy minds in healthy bodies are necessities for fulfillment of the individual missions of the graduates; and that fullest efficiency under this mission can only be attained if, through just and humane yet firm discipline, the graduates carry into the service respect and admiration for this academy.

One word expresses aptly the thought inculcated in the minds and characters of midshipmen and that word is "responsibility." From the moment that a midshipman is sworn in, he is given responsibilities. The first day he is at the Academy, he gets and marks his uniforms and other clothing, he cleans his own room, he becomes custodian of official books, and soon, when his turn comes, he is placed on duty assisting in the administrative office of his battalion.

During the academic year, the entire corps of midshipmen is organized as a regiment of four battalions of two companies each. In this regimental organization, the officers and noncommissioned

officers are midshipmen of the first or senior class, who have been carefully selected by the Academy authorities for such midshipmen ranks. It is a great honor to be a midshipman officer, as well as there being special concomitant privileges associated therewith. Each day, a different watch squad of about forty midshipmen has the actual administration of the regiment in the regimental office and the four battalion offices. The commissioned officers are in the background to give advice and assistance to the midshipmen only when needed.

It is plain that the Naval Academy sets a high standard. Not only does this apply to the midshipmen, but also every officer on duty there, from the rear admiral, who is superintendent, down to the youngest lieutenant, is expected to do his best to live up to the standard and set an example to the midshipmen in officer-like qualities and performance of duty. A dental officer assigned to duty at the Naval Academy, if he has personal pride and pride in his profession, is bound to feel a strong desire to attain in his particular branch the same degree of efficiency as holds throughout the Academy.

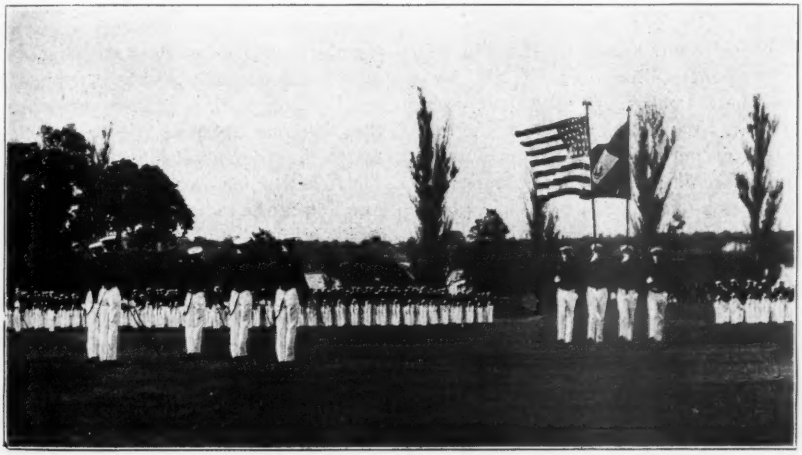

Fig. 3.—Dress parade.

The number of midshipmen at the Academy depends in general on the appropriations made by the Congress of the United States. In recent years, between 600 and 650 would enter each summer. As many drop out before the end of the course, the graduating classes lately have numbered from 440 to 470. The graduates are given commissions as ensigns in the Navy, the rank of ensign corresponding to that of second lieutenant in the Army.

While serving at sea in 1928, I received orders assigning me to duty at the Naval Academy where I would be in charge of the dental activities, which are known as "Dental Quarters." As those orders were received several months before they were to be carried out, there was time to consider the prospect and gather some information. It was realized that midshipmen are virtually dependent on the facilities of the Naval Academy for

the dental care which they receive. It was plain that all midshipmen should receive all needed treatment. It was known that many of the midshipmen had been cared for by the best type of civilian practitioner before coming to the Academy. They should feel that the care received at the hands of the dental officers of the Navy was not inferior to that to which they were accustomed. As officers of the Navy after graduation from the Academy, they would carry throughout life the first impression of the Dental Corps personnel. If that impression could be favorable, they would throughout life be inclined to recognize the value of dental care.

From young officers on the ship who were recent graduates of the Naval Academy, it was possible to get valuable suggestions from the viewpoint of the erstwhile midshipman patient. For example, it had been a moot point for years as to whether a midshipman could best afford time for dental treatment during a study hour or by missing a recitation. This will be explained in greater detail later, but it may be remarked here that most midshipmen at the Academy were strongly in favor of missing recitations! Those officers who had graduated a year or more before and who had put aside schoolday ideas were equally strongly of the opinion that the midshipmen should *not* miss the recitations and that dental treatment should be rendered in the study hours, the midshipmen having been given advance notice.

The graduates of the Academy also felt that the dental officer in charge could well take the full responsibility for the periodic examination and treatment of midshipmen and that it should not be left to the judgment of the young midshipman to apply for treatment when he thought it necessary. These and other suggestions I carried in mind on going to the Naval Academy to take up the duties assigned me.

At the Academy, an estimate of the situation showed that there were approximately 2,000 midshipmen, whose ages at time of entrance ranged from 16 to 20 years, and, the course being four years in duration, the total range of age was from 16 to 24 years. Among persons of those ages, we expect to find a high degree of susceptibility to dental caries. To preserve the teeth and particularly to prevent the involvement of the dental pulp, treatment should be thorough and at frequent intervals. In addition to the midshipmen, there were more than 400 officers, including the large number then attending the postgraduate school. Many of those officers had been on ships or at stations where they had not received adequate dental treatment and so needed it badly. Also, at the Academy, on the station ship, at the hospital, at the radio station and in other activities in the vicinity were approximately 700 enlisted men, whose need for dental treatment was as great as that of the officers.

To care for this large clientele, there was a total of six dental officers. There were five enlisted men to do all the clerical work, janitor work and roentgenographic work, prepare materials and dressings, handle stores and supplies and assist at the chair in the dental operating rooms. The space assigned as dental quarters was suitably situated on the top floor of Bancroft Hall, which is the dormitory and administrative building for midshipmen. The total floor space was about adequate, but was not suitably assigned in that practically no changes had been made since the space had been used as midshipmen's living quarters. Those quarters consisted of six double suites. In each suite, the midshipmen's furniture had been removed and a dental chair placed as close as pos-

sible to the window of the large room and the result called a dental operating room. Some of the smaller rooms were used for storerooms, x-ray room, prosthetic laboratory and administrative offices.

It was plain from the excessive number of patients to be cared for and the limited facilities that a high degree of efficiency must be attained even to approach complete dental care of the personnel. A steady flow of patients throughout each day with no broken appointments, each patient being allotted sufficient time but with a minimum of surplus time, would help one toward attaining the needed efficiency.

Just at that time, the Naval Academy Regulations had been changed, and it was made obligatory that routine dental treatment for midshipmen be rendered during their study hours. Offhand, that would seem a simple requirement, but, on examination, it was found that midshipmen of each of the four classes were assigned to four different battalions, that is, each battalion was composed of midshipmen from all four classes, that all midshipmen of one class did not study at the same hour, that those of certain battalions recited while those belonging to other battalions studied, that each month there was a reversal in the order of studying and reciting, and dozens of other complications which need not be told to prove that there was some difficulty in carrying out the order. Special lectures and special laboratory periods frequently were announced on short notice and, on such occasions, midshipmen would be required to attend in time ordinarily available for study (or dental treatment). It was obvious that it would be impracticable to ask each individual midshipman when he would be available for examination and treatment.

It was equally obvious that some way must be found to determine readily when any particular midshipman would be available for a dental appointment. After much study, a diagram seemed the best device. Further study and trial resulted in a diagram made to cover an academic month. The constant factors for any and all academic months were worked into a drawing and, from a tracing, a Van Dyke was made and, from this in turn, a supply of blue prints were made.

To explain the use of the Van Dyke: It is common knowledge that the ordinary blueprint has white lines corresponding to the black lines in the tracing and the field is blue. Subsequent entries in black or red would not show up well on such a blueprint. A Van Dyke is made by printing through the tracing cloth on a thin photographic paper which, when developed, gives white lines on a dark brown field. When the Van Dyke is then used to make a print on blueprint paper, the resultant lines are blue and the field is white. On such a blueprint, entries can be made with any colored ink or pencil and be easily legible.

One blueprint was used for each particular academic month and the information regarding classes was blocked in so that it became in effect an employment chart showing the hours and minutes of each day that midshipmen were engaged in classes and the exact times that they would be available for dental appointments. Each large square represented the part of the day that midshipmen might be available. Each of the four vertical columns represented one of the four classes. In each column, each of the smaller squares represented approximately an hour of time for that particular class. The smallest squares represented midshipmen of the class who belonged to certain battalions.

By applying the information found in

the Naval Academy academic calendar, bit by bit, class by class, battalion by battalion, for each hour of each day, by shading or blocking off the squares for the midshipmen involved, the result was that midshipmen left available were indicated by clear squares. In each square, the number of the battalion appeared; at the head of the column, the class, and, at the side of the small square, the beginning and terminal time, to the minute, of the time that group of midshipmen were available. While the foregoing explanation may not be entirely clear, it can be said that the necessarily very complex schedule of the entire regiment was reduced to a simple form so that anyone with a few minutes' practice could ascertain at a glance the availability of any subgroup of midshipmen.

One enlisted man was assigned the duty of keeping this chart up to date and using it to make all the midshipmen's appointments for all the dental officers. For each midshipman, there was a dental record which showed his name, class and battalion. If the appointment clerk wanted to assign an appointment for a particular midshipman, a glance at the chart would show at what hours midshipmen of his class and battalion would be available. If, on the other hand, it was desired to fill a certain period of time, the chart showed to which class and battalion the prospective patient must belong to be available and a record was chosen from the file which agreed as to class and battalion.

Appointments were made only one day in advance, which permitted the latest information to be applied. There were about fourteen factors involved in assigning a dental appointment to a midshipman, ten of which were covered by the chart. Four others, namely, the hospital list, sick list, "ship list" and watch squad list, had to be consulted after a midshipman was found to be available according to the chart. That was comparatively simple. The aim was to call only midshipmen who were nearly certain to be able to keep the appointments. If a midshipman was taken sick between the morning of one day and the hour of his scheduled appointment for the following day, he would miss the appointment. That did not happen often, and a high degree of efficiency was attained in the appointment system.

To carry out the idea of the dental officer's taking the responsibility for the professional care of each patient's teeth, it was decided that there would be certain advantages in having each patient assigned to a particular dental officer as long as the patient and the dental surgeon were at the Academy. Accordingly, each dental officer was assigned one class of midshipmen or a part of a class. This simplified matters in making schedules of appointments.

Soon it was found that there were certain hours of some days when no midshipmen of certain classes would be available. Then, the officers and enlisted men on duty at the Academy and in the vicinity were divided into groups and each dental officer was assigned one of these groups as patients. If no midshipman was available, an officer or enlisted man was assigned an appointment to fill the time.

The appointment system having been worked out, the program was started of sending for each midshipman every four months, removing the deposits from his teeth, reexamining them and filling all cavities with a permanent filling material. In mentioning the four-month period, it should be explained that, each summer, half the midshipmen go on a three months' cruise and all but the plebe or incoming

class are granted leave in the month of September. Therefore, if each midshipman has complete dental attention every four months during the time that he is present at the Academy, on an average he receives service about every five months for the entire academic course. It was found that such an average period was not too short considering the age of susceptibility to dental caries of the patients and having in mind the desire to arrest dental caries before the involvement of dental pulps. Every midshipman and officer was examined at least once a year by the dental officer in charge of dental quarters in addition to the examination every four months by the dental officer treating the patient. That examination showed what treatment was required and what had been done for the midshipman since his entry to the Academy. It was one way for the dental officer in charge to be familiar with the needs and verify the efforts to meet those needs.

During the academic year 1928-1929, it was found impossible to keep up with that program with the personnel and facilities then in dental quarters. By the end of that year, the officers of the executive department of the Academy were keenly enthusiastic about helping the dental officer in charge to improve facilities. Authority was obtained to remove the partition between what had been two midshipmen's bedrooms, thus providing suitable space for an additional dental operating room. Another dental officer was added to the personnel and the enlisted force was increased. About that time, there was an increase in the number of midshipmen, officers and enlisted men at the Academy, which largely offset the increased capacity of the dental quarters.

Systematic care of the patients began to show its effect, and there was a slow gain. In the following year, two more dental operating rooms were provided, four small rooms being made into two of suitable size by removing partitions; and two more dental officers were assigned to the Academy for duty. Then, it was possible to have two dental officers assigned to care for each class of midshipmen and to have the officer patients and enlisted patients equally well distributed. In consequence, it was possible to keep up with the program of complete dental treatment for every midshipman every four months. For the first time, in many years at least, the members of the graduating class went out of the Academy dentally fit and the undergraduates also were in a state of dental health. Officers and enlisted men were receiving dental care in the same way.

The method by which patients were called back every four months may be used by some civilian practitioners and is therefore worth describing. It has been stated that there was a dental record for each patient. Those were filed on edge, arranged in alphabetical order, by classes. When treatment of a midshipman was instituted, a few days after he had entered the Academy, a metal clip bearing the abbreviation for the current month was attached to the record. When the patient's mouth was placed in a state of health, that clip was removed and a clip for the fourth month off was substituted. When that month was reached, the patient was given an appointment for prophylactic care and reexamination. If other treatment was required, he received subsequent appointments, until the treatment was completed. Then that clip was changed for that of the fourth month off. The appointment clerk, in making up a schedule of appointments, was concerned only with the records bearing the clips for the current month. The clips stood up above the records in the file

drawer and each month's clips made a row by themselves. Each month's clips had a distinctive color. It was found that it increased efficiency to have such a means of making it easy for the clerk to do his work well.

The dental officer treating the patient would indicate on the record how many minutes he wanted the patient at the next sitting and the appointment clerk would assign the proper length of time. Sometimes, it would be impossible to fill a schedule of a day's time for a dental officer giving each patient the exact number of minutes requested. In that case, a patient or patients would be assigned slightly more time than was requested by the dental officer.

After making out the next day's schedules for all the dental officers, the appointment clerk filled in appointment notices for all midshipmen. These forms were carefully drawn up to require the minimum of work in filling them in and to make them mistake-proof on the part of the midshipmen patients. A typed list of all midshipmen appointments was made out in triplicate to furnish the information in that form to the regimental and battalion offices and for retention in the dental quarters. To describe it makes it seem a considerable amount of clerical work. In actual use, it was not, considering the large clientele, the conditions that had to be considered and the large number of patients treated each day.

The majority of the treatments rendered were, of course, of a routine nature. The dental officers showed great interest in catching up with the treatment of their cases and took much pride in the routine care of their particular groups when they succeeded in keeping ahead of dental disease. Cavities were filled before they had made extensive progress and there was great satisfaction in the almost complete elimination of pulp canal cases. The few pulp canal cases were mostly those arising from death of the pulps under fillings inserted before the patients came to the Academy.

The matter of impacted third molars presented somewhat of a problem. It had been noted in the Navy that many impacted lower third molars sooner or later caused trouble and that the later in life they were removed, the more difficult the operation was for both the patient and the operator. At the Academy, it was found that impacted third molars were the cause of considerable trouble. Sometimes, acute symptoms would arise at a most inopportune time, such as during a monthly examination week, and in one case, a star football player missed a week of practice and an important game because of an impacted molar. There are more important things than football games, but if the dental officer can prevent even such a minor misfortune as befell this football player, it is worth his thought and effort.

In the Navy, one cannot refer the difficult extraction cases to a specialist, no matter how much he may desire to do so. He must become competent to handle the cases himself. The fact that the majority of the patients are healthy young adults is of advantage. The midshipmen are a particularly healthy lot. On the other hand, certain consideration must be given to their situation as students as regards the removal of impacted teeth. All students are under a nerve strain. The farther they have gone in the academic year and in the academic course, the greater the nerve strain. This fact was apparent in the reaction of midshipmen to the operation of removal of an impacted molar. The upper classmen reacted more than those in lower classes. A midshipman could not well attend

classes soon after an extraction, while his mouth was sore and possibly there was some bleeding. That meant placing a midshipman on the sick list, with the consequent missing of classes for at least a part of a day.

In view of the foregoing, all midshipmen, shortly after they entered the Academy in June or July, were reexamined. Those whose first and second molars were present and whose lower third molars were not erupted were given roentgenographic examination. If the third molars were absent or seemed likely to erupt normally, a notation to that effect was made on the record. If the third molars were found to be impacted, they were removed at subsequent sittings. In most cases, owing to the youth of the patients, the roots of the tooth were not fully calcified and the operation was much simpler than if postponed even a few years. The patients were under no nervous strain as classes are not started for the plebes until September, their time in the summer being taken by drills and rifle practice. Even the weather was most favorable and there was the minimum of reaction.

There was one miscalculation in this plan. The incidence of impacted third molars was much higher than was expected. The first summer that the program was in effect, the two dental officers engaged in caring for that particular class of new midshipmen did not succeed in removing all the impacted molars in addition to the routine of filling cavities and removing deposits from the teeth. For the extraction of the few remaining impacted molars, it was possible to choose the most favorable times during the ensuing academic year; and when the midshipmen went on their practice cruise there was no remaining diagnosed case of impacted molar among the more than 550 midshipmen still in that particular class. If that program or plan could be carried out year after year, trouble from impacted molars would be prevented among most of the officers of the Navy.

Midshipmen come from every section of every state in the Union. They are all within a narrow age range and they are picked physical specimens. The records on them are complete. Such a situation is inviting to anyone who is interested in gathering dental statistics. The fact that, at best, the force of dental officers was just able to render all the needed dental care precluded spending any great amount of time on statistical research. In one of the annual examinations by the dental officer in charge, it was noted that among the more than 2,000 midshipmen, there were forty-five who had 28 teeth each, not counting third molars, and none of these teeth had a filling or a cavity. Those apparently caries-immune cases offered a chance for study. In odd moments, over several months, a questionnaire was worked out to inquire into the patient's early history, family history and other facts which might have a bearing on the case. By the time it was possible to interrogate the patients, the number had dwindled to thirty-five, the others having left the Academy or cavities having developed in their teeth.

When those thirty-five questionnaires had been filled out, another thirty-five midshipmen who were of average or marked susceptibility to dental caries were similarly interviewed. These data need to be worked over before they can be well presented. The preliminary conclusion was that, in the comparatively small number of cases studied, the factors in immunity to dental caries appeared to be heredity and the early diet and that oral prophylaxis was a negligible factor, if a factor at all. It is hoped that the

results of this brief study may be presented at a later date.

In a general way, it would be possible to plot the areas in the country where persons who are native to the locality have mottled teeth by finding out the homes of the midshipmen with mottled teeth. One of the caries-immune cases came from the outskirts of Amarillo, Texas. The teeth were not mottled and were nearly perfect. The patient stated that the children of Amarillo who had used the town water supply had mottled teeth. His home had its water supply from a well. Such a statement is interesting and suggests further investigation. In recent months, the theory has been advanced that mottling of the teeth is due to the presence of fluorin in drinking water.

This account of the dental care of midshipmen at the Naval Academy is offered as describing a practice approaching the ideal set forth in the opening paragraph and to show that even such a practice has its problems. It is also offered as an example of what thorough, organized, systematic professional care can do for a fairly large group of patients. It must not be thought that this is the usual accomplishment in dental care in the Navy. In very few instances has it been possible to concentrate the personnel and facilities in one place sufficiently to approach that result.

A battleship with as many as 1,400 men and officers carries one dental officer. Such a situation is not comparable to that in a village of 1,400 population; for, in the village, there are many who would not receive any dental treatment. Of the 1,400 on the ship, all are male adults, most of them in young manhood. They are all entitled to treatment and it costs them nothing. The factor of fear of dental treatment is practically unknown or is overcome. There is no controverting the fact that the dental officer of the ship has 1,400 patients, more than three times as many as he can possibly serve.

Methods similar to those used at the Naval Academy could be used almost throughout the Navy were the personnel and facilities adequate; but, of course, the present allowance of one dental officer to each thousand of Navy personnel does not permit it. Should the Navy ever have an adequate dental service such as has been described, great benefit would result to both the public and the dental profession in civil life, for the following reasons: Every officer and enlisted man would come to accept the thought that complete, regular dental care by the dental surgeon every four or five months was the proper procedure. Realizing that, because of such care, his own natural teeth were being preserved and retained, he would send his family to civilian practitioners to receive the same care. At the expiration of the enlisted man's service, he would go to the civilian practitioner himself or arrange that he be sent for at regular intervals to have continued the care to which he had become accustomed. The idea would tend to spread to friends and neighbors not connected with the Navy. In other words, this would be a way of educating a large number of persons to the value of dental health and the part the dental surgeon has in maintaining it.

The dental officers of the Navy, if they were adequate in number, thus would have a chance to do a service of general benefit by carrying out that which is their primary duty; namely, the care and preservation of the teeth of the officers and men of the Navy and Marine Corps.[1]

1. The opinions or assertions contained in this article are the private opinions or assertions of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.—Article 113, U. S. Navy Regulations.

IS THE SURGICAL ERADICATION OF PYORRHEA OUR RESPONSIBILITY?*

By HARRY M. McFARLAND, D.D.S., Kansas City, Mo.

MY object in presenting this paper is not solely in an endeavor to solve new problems in research or to suggest a new surgical technic. I am especially interested in helping each and every member of this organization by emphasizing our responsibilities and enabling you to visualize a broader field of service.

Probably more patients present themselves to members of our specialty for the removal of focal infection than to those of any branch of medicine. We perform more surgical operations in the mouth than any other specialist in surgery, and therefore are more qualified and more familiar with oral surgical procedures than any other specialist of the dental profession.

No longer is there any question as to the serious complications that may arise from infection of the teeth and oral cavity. These facts have been so well established that the medical profession and the laity are demanding more cooperation from the dentist. The dental profession as a whole has been too little concerned regarding the physical findings in their cases. Our members have been slow to cooperate with the medical profession. Perhaps the patients are more in earnest regarding the elimination of dental infection than is the dentist. This is probably due to the fact that the dentists, especially those in general practice, have been inclined to think in terms of mechanics rather than in terms of health. This fact has established a custom among the laity to consult the physician in regard to their teeth. Owing to the lack of cooperation on the part of many members of the dental profession, physicians are inclined to refer patients to other physicians for a general radiodontic examination. The physicians confer with each other and the patient in regard to the case and often instruct the patient and the dentist as to what is necessary. The dentist is consulted last in regard to the work on which he should be the authority. The members of the dental profession alone are responsible for this condition, and it has been brought about by their lack of interest in the health welfare of their patients and in the failure of the medical profession to receive the cooperation to which it is entitled.

We are aware of the fact that there are different kinds of infection in different mouths; that one kind of infection in one person will bring about a certain systemic disease, while apparently the same infection in another person will result in entirely different symptoms. These are conditions which no one has been able to explain; but we do know that when certain infections are eliminated, in many cases, the patient makes a complete re-

*Read before the American Society of Oral Surgeons and Exodontists, Memphis, Tenn., Oct. 17, 1932.

covery. Again, it has been proved that, in many instances, when root-end infections have been eliminated and the disease from a pyorrheic source has been allowed to remain, the patient did not get well; but later, if the infection from the pyorrheic source was removed, the patient made an uneventful recovery.

Quoting from Dr. Gardner[1]:

> Further knowledge of the pathologic aspect of pyorrhea shows that it plays the same rôle in focal infection as does infection at the apices of teeth. The condition of two patients who were observed in the clinic are illustrative of this point.
>
> A man, aged 35, had suffered from arthritis for four years. The tonsils and all pulpless teeth were removed. The result of this treatment was very satisfactory, for a time, but the patient returned with another attack of arthritis, associated with acute iritis and prostatitis. After his first visit to the clinic, several pyorrhea pockets developed, and from them, a pure strain of streptococcus was cultured. Cultures from such pockets are not obtained as constantly as from apices of pulpless teeth. Several rabbits were injected intravenously and iritis resulted. The response to treatment of the prostate was not satisfactory, a result that is to be expected if dental infection is still present.
>
> A woman, aged 45, had subacute infectious arthritis. Foci of infection other than pyorrhea were not present. One culture yielded a pure strain of streptococci. Cultures on animal inoculation were positive.

If we allow infection from a pyorrheic source to remain, knowing that it may cause serious complications, why do we remove teeth that have infected root ends?

This brings us to the subject which I wish to emphasize: We have all been assigned the responsibility of the eradication of disease conditions in the mouth and are confronted with the necessity for surgical treatment of pyorrhea.

1. Gardner, B. S.: Management of Infected Teeth in Practice of Group Medicine, J.A.D.A., 16:1013 (June) 1929.

It has been proved beyond a doubt that infection from a pyorrheic source frequently causes serious systemic complications. I continually meet patients in whose mouths the teeth are all vital, but who are suffering from various systemic disturbances, and these patients make complete recovery after the surgical eradication of the pyorrhea. The outstanding systemic disturbances have been acute attacks of neuritis. Such patients made a complete recovery after treatment. My research work in the clinical laboratory reveals the presence of short chain streptococci infection in these cases, that is very virulent.

Those interested in the elimination of pyorrhea by instrumentation believe that they get definite results. The treatment is beneficial and unquestionably secures the desired results in many cases. It is not the intention to change the form of treatment advocated by many dentists, but to suggest additional possibilities of treatment, thereby broadening the field of service.

> Some exponents of the instrumentation methods claim that the reattachment takes place between the soft tissue and the cementum on the exposed surfaces of the root. If such repair did occur, the ideal would be obtained and it would be quite unnecessary to look for a better method of treatment. The closing up of the former pocket would establish a normal condition aside from the lost process. However, reattachment has never been proved conclusively, either microscopically or clinically, to the satisfaction of all. If the soft tissues do not become attached, then we must admit that the pockets caused by the periodontal lesions still exist after treatment and are always liable to be reinfected. By instrumentation alone, the infected tissues and the necrotic bone are not removed or the margins of the alveolar process made smooth.[2]

In addition to this, there are granu-

2. Blanquie, R. H.: D. Cosmos, 70:170 (Feb.) 1928.

lomas that have a definite blood and lymph supply, small blood capillaries constantly carrying infection into the blood and lymph stream, lowering the resistance, probably developing an organic lesion that may be permanent and thereby shortening the lives of those entrusted to our care.

There is often an excess of soft tissue and frequently the overlying tissue forms a pus pocket of considerable depth. Various kinds of drugs have been used in an attempt to eradicate the excess tissue. Certain types of soft tissue can be removed by the application of caustics, but, in most cases, it is easier for both patient and operator to remove the tissue surgically. The technic has been perfected to the extent that the results obtained are apparently better than have been secured by any other method.

The eradication of pyorrhea by surgery is not new. It has been practiced a sufficient number of years to prove that it is based upon sound principles, and it seems to be the only definite way to eradicate the disease and rebuild new tissue.

While surgical methods are not advised in all cases, there is a large field in which surgery is indicated. The method is strictly a surgical procedure and should be employed only by those who are familiar with surgical principles. The oral surgeon is schooled in the principles of surgery. He is especially qualified to select and administer anesthetics, either general or local. He has made a special study and is familiar with the physical findings in patients. He understands the necessity of preoperative sedatives, of preoperative and postoperative treatment. His office is especially equipped with an autoclave for surgery rooms, especially arranged and prepared for surgical procedures. The office is arranged to accommodate patients recovering from anesthesia and the operation. Nurses are employed who have been especially trained in surgery and are qualified in caring for surgical cases.

Surgery of the mouth does not differ in principle from general surgery. What other specialist is so well qualified as regards professional training and equipment to surgically eradicate pyorrhea? For example, certain teeth are to be lost; the adjoining teeth are vital and firm in the alveoli; there are granulomas around the teeth in the interproximal spaces under the mucoperiosteum; the periodontal membrane is being destroyed; the alveolar process around the teeth is absorbed, becoming diseased and porous; the crest of the ridge around the teeth is sharp. Surgical procedures are necessary to bring about the desired results. Do we wish to assign this responsibility to someone else, trusting that they will use the proper technic?

We must realize our responsibility when we take into consideration the health of our patients, the results to be obtained by the eradication of the disease and the countless number of teeth that may be saved.

Patients are interested in saving their teeth — not in losing them. They will willingly pay more to save their teeth than they will to have them removed and replaced. Patients are interested in retaining or restoring good health conditions and desire to have teeth removed only when necessary. When we explain to them an operation that will remove the condemned teeth and eliminate the pathologic condition under one anesthetic during the same operation, the need of the service is made more convincing.

Having emphasized our responsibility in this added service, last but important

is the subject of remuneration. Those interested only in the removal of teeth may find one or several teeth to be removed, representing a comparatively small fee; but in getting a broader vision of our responsibilities of the elimination of disease and acknowledging the necessity of surgical eradication of the infection of pyorrhea, the findings of the general radiodontic examination, and recorded on the diagnostic chart, may indicate the necessity of a number of operations, representing a very substantial fee. When existing conditions are explained to patients and the service outlined, setting forth the necessity from a health standpoint and in addition stressing the saving of the teeth, they readily consent to the service and are gratified to know that such service can be rendered. Some members of our specialty have been able to save countless numbers of teeth, restoring the patient to health, and more than doubling their gross income as a result of this added service.

Understand that it is not the intention to infringe on any one. We all have our place and our field of usefulness in the care of various cases as the different treatments are indicated. There are conditions that are preferably handled by surgical procedures, and when such cases arise, they should be handled by those specializing in oral surgery. It is my opinion that unless members of our specialty do the necessary surgical work, it is generally not going to be done. Dentists, as a rule, in the practice of periodontia or in general practice, do not invite or advocate such surgical procedures, for the reasons here outlined. These facts being true, our responsibility in our chosen field is to cooperate in every way in the eradication of oral infection and to use adequate surgical measures in rendering this valuable professional service.

DISCUSSION

H. M. Taylor, Knoxville, Tenn.: It seems to me that the treatment of pyorrhea is really out of our field of endeavor. Of course, there are cases which we could handle better than a periodontist can, but if I understand pyorrhea correctly, there is much more to its treatment than the surgical elimination of pockets. As we are oral surgeons and exodontists, I do not see how we could possibly take care of the case as it should be taken care of. How are we going to remove calculus? Its removal and the prophylactic treatment of the case, which are usually necessary, certainly are not surgery, and I doubt that we could profitably take care of these cases without going outside of our field of surgery.

Menifee R. Howard, Denver, Colo.: Surgical treatment of pyorrhea is truly a surgical procedure and therefore comes within our field of work. As has been suggested, if those of our specialty do not do this type of surgical work, in many cases the work will not be done and a valuable field of service will be neglected. Shall we interpret the definition of our specialty as simply being the extraction of teeth or shall we have a broader vision and include other types of dental surgery that apply to the health of the patient? There seems to be some difference of opinion on this point. My opinion as to the ethics of our specialty is that we should be fair with our patient and eliminate infection from the patient's mouth. If we do that by surgical means, I cannot see what difference it makes whether the operation is for pyorrhea or the removal of a tooth or in treatment of any other dental infection. When a physician refers a patient to a dentist, particularly to one in our specialty, for the elimination of dental foci, he expects the infection to be eradicated also. If we do only a part of the work, and pass the responsibility to someone else, are we shirking our duty? This is a question that requires serious consideration. An eye specialist of my acquaintance made observations in regard to the various methods of treating certain types of pyorrhea in the mouth. Tests were made by means of certain color fields. Special attention was given to cases of pyorrhea which were treated by the old method of instrumentation and those which had received surgical treatment. He found that the former method was not so effective as the latter in these certain

types as far as this particular test of the eye is concerned. In other words, according to his idea, the normal eye and body should give a certain color field reaction, the general field approximating 22 degrees. If there is a constriction of that general field of 5 degrees or more, there is an indication of focal infection. If the infection is of dental origin and is eliminated, the reaction goes up to a normal of 22. If the infection is not eradicated, the condition remains unchanged. The same eye specialist has observed that, in the surgical treatment of pyorrhea, when all other infections have been eliminated, the general field becomes normal in a short time after the operation. He also observed that, in certain types of pyorrhea cases treated by instrumentation, the color reaction either did not return to normal or there was only a partial benefit. At least, he has demonstrated to his own satisfaction that the surgical treatment is the most effective in certain types of pyorrhea infection. His findings certainly merit careful consideration. Whether pyorrhea should be handled surgically by members of our specialty or others of our profession is the question before us. If others are lax in their methods or for any reason are not prepared, or do not desire to do this type of work, we should, by reason of our surgical training, be prepared to do it. Finally, members of our specialty should prepare themselves to do this type of operating because, in doing so, we are rendering a greater and more efficient service to our patients, which is our responsibility, as well as broadening our field of activity.

Boyd S. Gardner, Rochester, Minn.: I think this paper is of extreme importance because there is a great amount of discussion as to whether the members of this society are going to be permitted to do this type of work without violating the by-laws. I know of a few dentists who would prefer to give up their membership rather than discontinue the treatment of pyorrhea by the so-called surgical method. I know of nothing more discouraging than to be asked to remove two hopelessly involved teeth in a mouth grossly affected by pyorrhea, and to have to leave untouched the rest of the mouth. In doing this, I feel that little, if anything, has been accomplished. If we consider the medical profession, and feel their pulse in regard to this problem, we find that they are asking us to eliminate infection, and they do not care whether it is in the tooth or around the tooth. Is it fair to anesthetize the patient, take out a loose tooth, and leave infection in adjoining teeth, when further treatment could have been done at the same time and perhaps save the patient from the necessity of another anesthesia? Does the exodontist always see that his patients are put into the hands of someone who will carry out the pyorrhea treatment in detail? We extract teeth and pass this responsibility on to someone else. Why can we not do the surgical work necessary to eradicate a condition of pyorrhea that cannot be treated by more conservative measures, and pass the patient on to someone else who will scale and polish the teeth, correct traumatic occlusion and attend to the necessary replacements? We have a two-sided proposition and we must arrive at the best solution. We have a new proposition to face, and it emphasizes this changing world. I assure you if I were an extracting specialist in any other city that I know in the United States, I would certainly enter upon surgical treatment of pyorrhea. The only reason I do not do it at Rochester is that our patients do not stay long enough. They are transient, and that is the reason we do not do more surgical work. We try to have the patient return to his local dentist, whether for prosthetic work or whatnot. If you were in my position and could see the many patients who are in need of pyorrhea treatment, you would share with me the feeling that there is room for many dentists to carry on this particular type of work. Moreover, we can aid the periodontist by helping to educate the people to the need for pyorrhea treatment.

A. L. Frew, Dallas, Texas: I would like to ask Dr. McFarland just how far he is going with the pyorrhea treatment, that is, with the surgical treatment. When he removes the excess tissue or gets rid of the pockets, does he scale these teeth and grind them to a balanced occlusion, or simply stop at the surgical part, leaving the rest for somebody else to care for? I know of periodontists who treat pyorrhea surgically. Are they not justified in doing so? If that is the method they follow, I believe that we are overstepping our bounds in surgically treating pyorrhea. The surgery that is connected with pyorrhea treatment is minor. We are simply removing a little gum flap. The periodontist has just as much of a right to come into our field and extract teeth. I do not

see where we can draw the line. If we are going to remove the flaps, we have also to scale the teeth. I do not believe a periodontist would appreciate our removing a thin flap of gum, exposing the neck of the tooth half the length of the root and, in many cases, making it very sensitive, and then turning the case over for him to finish. That would be very much the same as if we should remove a tooth and send the patient to somebody else for postoperative treatment. Most of the men, when they have such a case, do not want to be bothered with it. They are afraid to undertake it, and I think we would have very much the same condition in handling pyorrhea surgically.

Theodor Blum, New York City: I, myself, am not interested in operating in any pyorrhea case, but as long as any work is surgical, it certainly belongs to the one doing surgical work. There is no question about that. I know nothing about making a plate. I did make one once, I admit, in college. Does that mean I have no right to perform an alveolotomy? If I have sense enough to consult the man making the plate and let him advise what he wants me to do, that is all that is necessary. If you want to do what is called surgically treating pyorrhea, all you have to do is to consult the man handling the treatment. He is going to do the scaling and grinding, and you the surgical work. If I were the patient, I certainly would not want the pyorrhea specialist to surgically treat pyorrhea for me, nor want the prosthodontist to perform alveolotomies for me. It simmers down to one thing, the cooperation between the different specialists.

E. C. Hume, Louisville, Ky.: In Louisville, we have two men who are treating pyorrhea exclusively. I have had occasion to see one of those men do some excellent work in the so-called surgical treatment of pyorrhea. I am sure he showed much more skill than I could show, or some of the men from our city. As long as they are able to treat the condition in that way, I shall confine myself to those cases in which my consultation and help is sought. I have no feeling of alarm about this situation. Yet those men who wish to do this work do it. Dr. McFarland has presented a beautiful outline of his work, but I, myself, have not given the matter any attention and I do not see why I should attempt to do any great amount of this work. The men in our city who are doing this special work are conveniently located, and are treating pyorrhea with the strictest observance of surgical principles.

Dr. McFarland: I am not standing alone in this work, as there are other members of our organization who have had equal success in caring for such cases. Dr. Taylor referred to the removal of calculus, as did Dr. Frew, and Dr. Frew asked me just where I drew the line in taking care of these cases. I have tried to make it plain that we are not considering anything at this time except the surgical technic. If we have cooperation, and we do in our city, from others who are treating this disease, it is their duty to take care of prophylaxis, the grinding of occlusal surfaces, correction of the diet and whatever else seems necessary. If the operator is specializing in oral surgery and is not carrying the case to completion, he should assign these detail responsibilities to those cooperating with him. I desire to emphasize at this time that, in my opinion, better results can be obtained and that there will be prompter elimination of infection, which, in many cases, does cause systemic complications, by surgical procedure than by any other method. Dr. Frew referred to this as a simple procedure. I should like to ask him whether he has ever operated in one of these cases.

Dr. Frew: I have seen them. They do not demand deep oral surgery.

Dr. McFarland: My experience is that it is a very exacting operation, if properly done. It requires a great deal of time, care and skill. I desire to go on record as being more gratified with the results obtained by the surgical treatment of pyorrhea than with anything else that I have ever done in dentistry. Had anyone told me that healthy normal tissue, which has a high resistance to recurrence of pathologic conditions, could be produced by the methods suggested, I would have been reluctant to believe the statement without having had the actual experience. Dr. Frew, perhaps, would be of a different opinion if he had operated in cases of pyorrhea and not only had seen the results from the clinical standpoint, but also had seen countless persons in whose mouths the teeth were all vital and who were suffering from various systemic complications, but who made a complete recovery after the elimination of disease. Dr. Gardner emphasized the necessity of closer cooperation with the medical profession. It seems to me that if we have a responsibility in this work at all, it certainly is along the line of health. If we expect to do anything to obtain

definite results, we must cooperate with the medical profession, and it has been proved by research, in the Mayo Clinic and elsewhere, that we do have serious systemic complications as a result of infection from a pyorrheic source. My experience with the men in general practice is that they are pleased to know that infection can be eliminated by such procedures and are willing to cooperate. Dr. Blum brought out the idea of cooperating with the various branches of dentistry. That is an important point. We all know that where harmony prevails, the results are more gratifying. As we become more familiar with the results that can be obtained in doing this work and realize its importance to health, we will recognize our responsibility in the surgical elimination of pyorrhea.

MEDICAL DIAGNOSIS OF PATHOLOGIC CONDITIONS OF FACE AND JAWS*

By WILLIAM LINTZ, M.D., Brooklyn, N. Y.

THE life of the patient may depend on a correct diagnosis. Therefore, it is extremely important for the dentist to know not only the local abnormalities, but also the local manifestations of general disease that may have its expression about the face and jaws, for frequently swellings which simulate these conditions have a dental origin. As a rule, the patient presents three symptoms when he visits the dentist: (1) pain, (2) swelling, and (3) interference with function. Let us consider these seriatim, for this method will generally lead to the correct diagnosis. From a medical standpoint, these swellings may be divided into noninflammatory and inflammatory.

SWELLINGS OF THE FACE

Noninflammatory.—1. Heart and kidney disease will almost invariably produce swelling of the face during some stage of their course. This can be readily diagnosed and differentiated. In both conditions, the swelling is painless and the skin pale. If the swelling is due to heart disease, at the beginning of its course, it is only perceptible at night, and is preceded by swelling of the feet. If due to kidney disease, the swelling is perceptible in the morning when the patient first arises and is located chiefly beneath the eyelids. In other words, in heart disease, it is gravity, while in kidney disease, it is the looseness of the tissues that decides the location and the time of swelling. A thorough examination of the heart and urine will establish the diagnosis.

2. Obstruction of the superior vena cava may be caused by fibrosis, mediastinal tumors or aneurysm. Disturbance of circulation, as indicated by markedly distended veins of the head and neck symptoms referable to the chest, in addition to the swelling of the face, will draw the attention of the dentist to the true significance of the facial edema.

3. Angioneurotic edema is a colorless swelling of variable size, which may be located over the upper or the lower

*Read before the Unity Hospital Dental Association, Feb. 16, 1932.

jaw, on the face or mouth, or, for that matter, anywhere on the body, may last for hours, days, weeks or months. Usually, it lasts a day or two and disappears as spontaneously as it came. As a rule, it is painless, although I have seen it associated with excruciating pain. Generally, it is accompanied by a sensation of burning and discomfort. It is an allergic manifestation caused by an extravasation of fluids from the capillaries into the surrounding tissue and is comparable to hives, ivy poison, hay-fever and asthma.[1] It is caused as a rule by the ingestion of certain foods.

Fig. 1. Mikulicz's disease (author's case). The type of swelling of the face is suggestive of a dental origin.

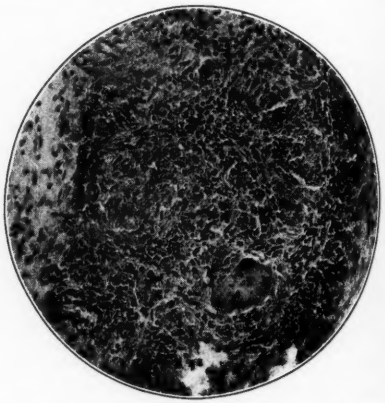

Fig. 2. Cross-section from salivary glands (author's case) showing evidence of tuberculosis.

although it may be caused by inhalation of or by contact with some substance to which the patient is susceptible. To recognize the true significance of the condition and to avoid needless surgery, a history of previous occurrences and the appearance of similar phenomena in other parts of the body is of great help. Usually, I find these patients suffering from other forms of allergy,[2] such as hives, hay-fever, asthma, migraine or allergy of the gastro-intestinal tract.

4. Temporary edema of the face after goiter treatment occurs in about 16 per cent of cases, whether the treatment of the goiter has been surgical removal or the medical application of roentgen rays to the thyroid. Such a history will make the dentist cautious.

5. Tumors such as fibroma, lipoma, cyst and epithelioma should present little difficulty in diagnosis.

Inflammatory.—1. Boils, carbuncles, wounds, chronic lymphangitis, erysipelas, alveolar abscess and dental caries will yield no diagnostic difficulties to the intelligent dentist.

2. Suppurative parotitis and mumps not infrequently come to the dentist's attention on account of simulation of the condition by infected teeth. The knowledge of the existence of similar

1. Lintz, William: Bronchial Asthma, M. J. & Rec., 119:278 (March 19), 1924.

2. Lintz, William: Study of Three Hundred Cases of Asthma and Other Forms of Allergy, Ann. Clin. Med., 3:653 (April), 1925.

cases, with which the patient has come in contact, the fact that the pain and swelling in the parotid region is in front of or below the ear and is usually bilateral, that the testicle or ovary is not infrequently involved and the reddened and inflamed openings of Stenson's ducts are present in the mouth, together with the fact that infected teeth can be excluded, ought to insure the correct diagnosis.

3. Mikulicz's disease is a rare condition of interest not only to the physician but also to the dentist. Twenty-two years ago, I presented before the Brooklyn Pathological Society my first patient,[3] who presented a characteristic and symmetrical enlargement of the lachrymal and salivary glands, chronic in character, nonpainful and not associated with any demonstrable systemic disease, and which could not be classified under any of the diseases heretofore described. On account of the obscurity of this disease, the tendency is to blame the teeth for this condition. As a matter of fact, the teeth have nothing to do with it. In my first case, as well as in several subsequent cases, I found tuberculosis, syphilis or the combination responsible for this disease. (Figs. 1 and 2.)

4. Anthrax chiefly affects workers in wool, horsehair and raw hides. It is characterized by the formation of a vesicle, which bursts, forms a scab and becomes surrounded by a ring of vesicles, around this being an area of edema. The diagnosis is made microscopically and bacteriologically by the discovery of anthrax bacilli in the fluid from a vesicle.

5. Vaccinia is an accidental infection about the face which may be mistaken for an anthrax pustule. An inquiry as to how it was caused and a bacteriologic examination will readily make the differential diagnosis.

6. Chancre, if situated on the face, is, as a rule, located on the upper lip. It is not so hard as when on the penis, but the surrounding edema is more marked and the neighboring lymphatic glands are considerably enlarged. *Spirochaeta pallida* can be demonstrated from the exuded serum in nearly all of these cases. The Wassermann test is not very reliable at this stage.

7. Insect bites from mosquitoes, bugs, gnats, etc., often cause disagreeable swellings. The history is a great help in their diagnosis.

SWELLING OF THE LOWER JAW

Noninflammatory. — These may be caused by a hematoma or traumatic periostitis following a blow or may be due to a fracture, with its obvious signs and, later, callus formation.

Inflammatory.—1. The most important inflammatory condition in the jaws, from a medical point of view, is not the acute, but of much greater significance is the chronic infection about the roots or apices of the teeth,[4] which leads to the formation of granulomas, inflammatory foci and closed abscesses, with rarefaction of the tooth and jaw bone, absorption of bacteria, and toxins and disintegration of inflammatory products into the circulation, giving rise to rheumatism,[5] heart disease, certain forms of respiratory diseases,[6] etc.

3. Lintz, William: Von Mikluicz Disease, New York J. Med., February, 1911.

4. Lintz, William: Teeth in Relation to Disease, J. A. D. A., 18:2318 (Dec.), 1931.

5. Lintz, William: Researches in Rheumatism, J. Lab. & Clin. Medicine, 3:509, (June), 1918.

6. Lintz, William: Respiratory Diseases and Teeth, M. J. & Rec., 133:62 (Jan. 21) 1931.

Certain dentists, as well as physicians with limited clinical experience and power of observation, deprecate the idea that these apical infections are ever dangerous or are even a source of trouble. They cite the fact that many patients have them without exhibiting the slightest symptoms, and even those who have rheumatism, etc., have had these dental infections for years prior to the exhibition of symptoms; that the eradication of these infected foci is not always associated with benefit to the patient, and, therefore, there can be no relationship between the dental infection and the disease exhibited by the patient.

The usual answer is that it all depends on the virulence of the germ and the resistance of the patient, and whichever state the patient is in, the explanation is based on the resultant of these two factors. Now, it is a fact that not all periapical abscesses yield living bacteria, a goodly percentage of them being absolutely sterile. The true explanation, I believe, of the foregoing rests rather on this fact than on any other. I am convinced from a large experience that, without roentgen rays, it is absolutely impossible to diagnose this condition in every case. Teeth that appear as perfect to the eyes of experts have repeatedly proved foci of dental infection on roentgen-ray examination. I believe that the only treatment for this condition is either extraction or the elimination of the infection by proper treatment. The theory that a pulpless tooth is never amenable to successful treatment is untenable, because it is a well-established fact that many of these teeth have been preserved for a lifetime without the slightest injury to the host.

Alveolar abscess, caused primarily by infection of a tooth, and necrosis of the jaw (often preceded by periosteal abscess) may follow not only injury and alveolar abscess but also syphilis, exanthemas, typhoid fever and mercurial and phosphorus poisoning.

2. A long-standing and obstinate suppuration about the lower jaw, with cellulitis of the neck and formation of sinuses in the skin, should lead to suspicion of actinomycosis. The finding in the pus of the small yellow granules, which on microscopic examination will show the mycelium, will establish the diagnosis.

3. While, as a rule, there is little difficulty in differentiating between inflammatory and neoplastic processes of the jaw late in the disease, there may be grave doubt at the beginning stages; and yet an early diagnosis in malignant disease is of greatest importance if we are to be of any help to our patient. Therefore, all possibility of inflammatory damage must be carefully excluded by a thorough examination of the mouth and teeth for any source of infection, and, for this purpose, the medical profession has long ago recognized that the cooperation of the dentist[7] is indispensable.

Nonmalignant tumors are osteoma and fibroma (fibrous epulis). Malignant tumors are primary sarcoma and secondary epithelioma, which start in the jaws or on the floor of the mouth and invade the jaw by direct extension. Odontomas are innocent tumors arising from any portion of the dental tissue, either from the tooth germ or from the fully formed tooth.

4. In acromegaly,[8] the lower jaw

7. Lintz, William: Necessity of Interrelationship Between Physician and Dentist, D. Outlook, 12:267, (July), 1925.

8. Lintz, William: Endocrine Glands and Teeth, Endrocrinology, 15:57 (Feb.), 1931.

is invariably conspicuously larger, becoming prominent, massive and prognathic. As the jaw bone outgrows the teeth, the spaces between them become very large. The remaining bones of the face as well as of the entire body also enlarge. Enlargment of the pituitary causes severe headaches, muscular debility, bilateral temporal hemiopia and changes in the sella turcica which can be recognized in a roentgenogram.

5. Leontiasis ossea is a rare disease in which hyperostosis of the facial and cranial bones are the distinguishing features, and which can be differentiated from acromegaly by the absence of changes in the hands and feet.

SWELLING OF THE UPPER JAW

What has been said of the lower jaw holds good for the upper jaw. Special attention has to be given to disease arising from the antrum of Highmore, especially sarcoma.

PAIN IN THE LOWER JAW WITHOUT SWELLING

Pain in lower jaw from dental caries, i. e., toothaches, is very frequently, and unerupted teeth[9] are comparatively seldom, the cause of pain. Roentgenograms may be necessary to diagnose the latter.

In neuralgia, pain is the main feature, either following the course of the nerve, such as the inferior dental, or affecting a considerable part of the jaw without special reference to any nerve. Pain may be slight or severe. Usually, in neuralgia of the inferior dental nerve, the other branches of the fifth nerve are affected; a fact which, together with the spasmodic character of the pain, makes diagnosis easy. When decayed teeth are present, the condition becomes difficult to diagnose until these teeth are extracted. Not infrequently, there is severe reflex pain over the neck and jaws in disease associated with the coronary blood vessels, such as angina pectoris and coronary thrombosis. Rarely, it is the only location, at the beginning of the disease, where pain is felt. The dentist and not the physician is consulted first by these patients. Unwillingly, the dentist removes tooth after tooth without relief before the true condition of affairs is recognized. When wholesale extraction fails to afford relief from pain, angina pectoris should be thought of.

I have repeatedly witnessed attacks of pain over the jaws during menstruation, without apparent disease of the teeth. Not extraction but administration of the proper endocrine gland products[10] help these patients.

PAIN IN THE UPPER JAW WITHOUT SWELLING

What has been said of the lower jaw in this connection holds good for the upper jaw. In addition, we have the inflammatory, both simple and suppurative, and neoplastic conditions arising in the antrum of Highmore. To diagnose, differentiate, and treat this disease is as a rule a simple surgical procedure.

36 Plaza Street.

9. Lintz, William: Unerupted Teeth, New York J. & Rec., 129:670 (June 19) 1929.

10. Lintz, William: Teeth and Internal Secretory Glands, D. Cosmos, 68:10 (Oct.) 1926.

OCCLUSAL RECONSTRUCTION AND BITE COORDINATION*

By E. E. BAILEY, D.D.S., Denver, Colo.

OCCLUSAL reconstruction is a very difficult operation for the patient and for the dentist. This condition cannot be eliminated from the ordeal. Nevertheless, for many cases, opening the bite and rebuilding occlusal surfaces is a necessity if dental health, utilitarian service, esthetics and comfort are to be realized.

Surely, a technic, no matter how perfectly conceived, will not do the work unless it is understood and applied with diagnostic judgment and reasonable skill. Herein lies the hazard. Dentists are prone to view a clinic, pronounce it good and attempt to apply it in practice with only an inkling as to what it is about. Failure too often occurs. Therefore, it is my plea that no dentist attempt to follow the technic to be described in this paper until he understands the philosophy of the scheme and the sequence of steps necessary to bring definite results.

I wish to acknowledge the work of Drs. Tinker, Monson, McCollum, Bronson, Coston, Loughry, Meyer and many others, from all of whom I have borrowed freely in perfecting this technic. I am indebted to Dr. A. G. Kelly, of Denver, for valued services rendered and to Drs. Brusse and Carmen, orthodontists of Denver, for a motion picture of the technic.

A brief outline of the different steps of the technic may help in gaining a clearer understanding of the descriptions that follow.

1. Accurate stone study casts are mounted on an adaptable articulator. They are to occupy the open centric relation in which the case is to be built. The articulator is adjusted to a protrusive checkbite of the mandible.

2. When study casts are mounted in correct position, no further registration of occlusion will be necessary from the patient during the building of the inlays, crowns and bridges. This is made possible by the use of an occlusal positioning guide, which is constructed on the study casts in the open centric position that they occupy on the articulator. The positioning guide enables the operator to carry his diagnosis accurately into the finished case.

3. Scientific study is made of the case for cavity preparation.

4. The preparations are protected with quickly constructed inlays and crowns of low fusing alloy (having a fusing range of 60-65 C.).

5. Impressions are made for amalgam dies.

6. Amalgam dies are constructed, and a method is described of molding their root ends in die sockets, which later become their seats in the master cast.

*Read before the Section on Operative Dentistry, Materia Medica and Therapeutics at the Seventy-Third Annual Session of the American Dental Association, Memphis, Tenn., Oct. 21, 1931.

7. Transfer inlays and crowns are constructed which enable amalgam dies to be accurately located in master casts.

8. An impression technic is employed which is easily handled, accurate and quick.

9. Master models containing dies of teeth to be restored are constructed.

10. A quick, definite technic of checking bridge areas for accuracy of transfer is employed.

11. Master casts are mounted on the articulator by the use of the occlusal positioning guide.

12. The case is constructed.

sents is to give a starting point from which to study conditions as they exist and to determine the degree of opening necessary to make the proposed correction. The bite is opened on the articulator to a point which meets the mechanical requirements. It must be clearly understood that this is only a step in arriving at the correct vertical height for the case as esthetics is an important consideration of the diagnosis. In many cases, the change in appearance is so great as to justify the operation from the esthetic standpoint alone. Therefore, after making a diagnosis of

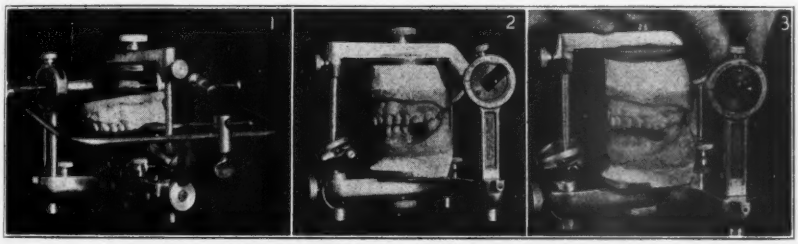

Fig. 1.—Initial mounting of study casts. *1,* **facebow mounting of maxillary cast;** *2,* **mandibular cast articulated by aid of worn facets and mounted;** *3,* **adjustment of condylar paths of articulator.**

MOUNTING STONE STUDY CASTS IN THE OPEN CENTRIC RELATIONSHIP IN WHICH THE CASE IS TO BE BUILT

At the time the impressions are secured, a facebow transfer is made and protrusive checkbite taken. No centric bite is necessary at this time, as the primary mounting is done with the aid of the worn facets of the cusps. The upper cast is mounted with the facebow transfer and the mandibular cast is articulated and mounted. The condylar guides are adjusted to a protrusive checkbite.

The object of first mounting study casts to the bite which the patient pre-

the mechanical requirements on the instrument, we must go to the patient for the study of esthetics and make any change necessary to harmonize these two factors. This is accomplished with metal bite-blocks which are built on the study casts to register the proposed opening. When transferred to the mouth, the blocks will hold the jaws in the same vertical relationship as the study casts occupy to each other. They are built by adapting 60-gage tinfoil over the occlusal half of the bicuspids and molars of the mandibular cast. A trough is made over the occlusal half by holding a folded damp napkin on each side of the tin. Low fusing alloy is

poured and patted to place with the finger. With a hot spatula, metal is built on or taken away until the articulator guidepin registers centric relation. With bicuspid region are touching. This is necessary as there must be no indentations to deflect the bite.

Up to this point, we are working with

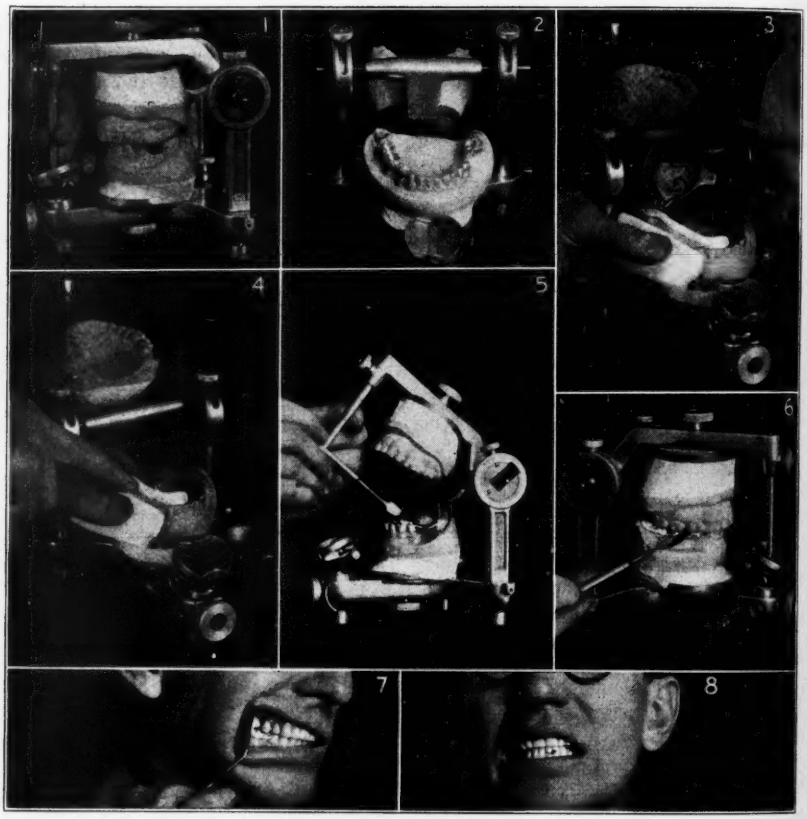

Fig. 2.—Construction of bite-blocks for mounting study casts in position of diagnosis. *1*, opening bite on articulator to meet mechanical requirements of case. *2*, adapting 60-gage tinfoil to occlusal half of bicuspids and molars. *3*, making trough with damp napkins and pouring low fusing alloy. *4*, patting to place with finger. *5*, shaping with hot spatula (occlusal surface should be smooth and flat). *6*, establishing point of contact on each side in bicuspid region. *7*, use of small bite-blocks permitting open vision. *8*, testing to be sure contact is even on each side preparatory to taking bite.

a large vulcanite bur and carborundum disks, the occlusal surface is finished so that only the points of the cusps in the an arbitrary opening. It is understood, I am sure, that bites are seldom correct when opened on an articulator. There-

Fig. 3.—Securing bite and remounting upper cast. *1*, placing bite-blocks on cast and adapting strip of baseplate wax, covering with 40-gage tinfoil. *2*, bite-block with wax covered with 40-gage tinfoil, which is softened in warm water. *3*, securing bite by having patient close to contact with bite-block. *4*, finished registration of bite. *5*, remounting of upper cast. Care is taken to set incisal guide-post flush with upper arm of articulator when remounting. *6*, study casts in position in which case is to be constructed.

fore, we never accept a centric relation which is not registered by the patient.

The bite-blocks are now placed in the mouth and carefully checked to see that contact is even on both sides when the jaws are closed. This is the time to begin the final study of the case to coordinate the mechanical requirements with the esthetic. If a wider or lesser opening is indicated, we simply replace the blocks on the instrument, set the guidepin to the desired opening, adjust the bite-blocks to contact, and again check in the mouth. Having satisfied

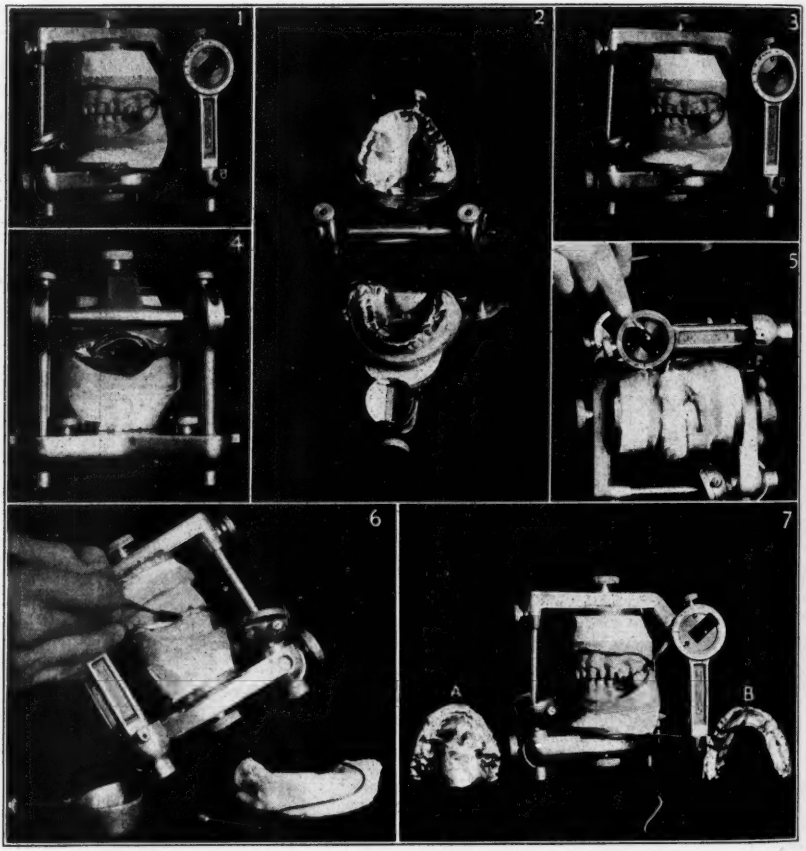

Fig. 4.—Occlusal positioning guide of alloy. *1,* **study casts in position of diagnosis ready for construction of occlusal positioning guide.** *2,* **adapting 60-gage tinfoil.** *3,* **instrument closed to centric relation.** *4,* **posterior view, showing manner of shaping tin to direct alloy between teeth.** *5,* **outer opening walled off with moist cotton and low fusing alloy poured.** *6,* **adding or removing alloy with hot spatula, in finishing buccal and labial surfaces.** *7, A,* **occlusal positioning guide before trimming;** *B,* **occlusal positioning guide finished.**

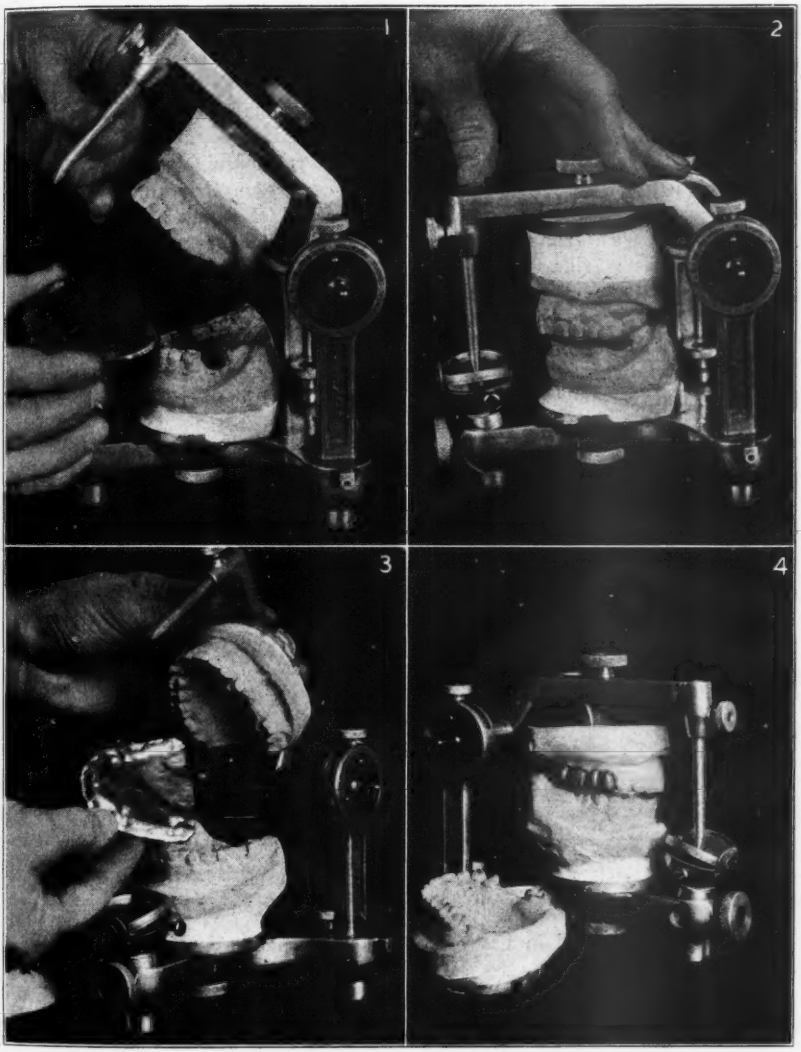

Fig. 5.—Construction of occlusal positioning guide of wax covered with tin. *1*, base-plate wax covered with 40-gage tinfoil, prepared and softened in warm water. *2*, placing in position and closing instrument to occlusion. The incisal guide table is set horizontal to avoid the spring of the instrument when force is used in closing the articulator. *3*, finished occlusal positioning guide. *4*, application. The master cast takes the place of the study cast in the occlusal positioning guide.

the patient and ourselves with the proposed opening, we proceed to secure centric registration in this position. By this time, we have a good knowledge of the case and know exactly where certain landmarks should register on the bite-blocks. Pencil marks bisecting teeth exposed to view, or a small wire secured to the low fusing alloy bite-block to make contact with definite points on each side of the maxillary arch, will enable the operator to know when the patient is registering correctly.

A double thickness of baseplate wax is placed on the occlusal surfaces of the bite-blocks and covered with 40-gage tinfoil. They are placed in water the correct temperature to soften wax, and the bite is secured by having the patient close to contact with the bite-blocks. The upper cast is remounted to the corrected bite.

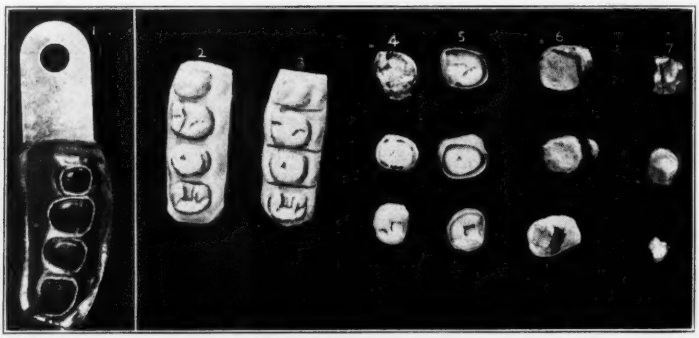

Fig. 6.—Temporary restoration of alloy on plaster cast, group technic. *1,* securing impression in compound. *2,* cast of accelerated plaster. *3,* cast sectioned with saw. *4,* plaster tooth carved so that gum line will form shoulder to create space between paper matrices and side walls of plaster tooth, for constructing crowns and three-quarter crowns. *5,* paper matrices in place. *6,* alloy poured and pressed to place with finger. *7,* finished temporary case.

OCCLUSAL POSITIONING GUIDE

We have carefully mounted the study casts in the position in which the case is to be built. Later, master casts, containing dies of teeth to be restored, will be constructed. The objective is to mount master casts accurately in the position which the study casts occupy. This is accomplished by building an occlusal positioning guide to register the centric relationship which the study casts occupy on the articulator. It is constructed of metal, or baseplate wax covered with 60-gage tinfoil. It should only contact the tips of the incisal and occlusal surfaces of the teeth on the study casts, as these points remain reasonably constant whether on study or master casts. Therefore, a master cast can be seated in the occlusal positioning guide and mounted to the opposite study cast. It is granted that some portions of the teeth will be reduced in cavity preparation. There is usually at least one tooth on each side of the arch which presents an unchanged cusp to balance the master cast in the guide. Since the incisors are not restored until the posterior teeth are finished, this area will be constant, and all that is needed is

one molar on each side to give balance in the guide.

Should a condition arise in which all teeth on one or both sides of the arch are restored with crowns or inlays the removal of which in the preparation would make the occlusal surfaces lower on the master cast, provision must be made to establish the relationship in the occlusal positioning guide. This is accomplished by placing baseplate wax in the guide to make contact with the most posterior tooth which has been lowered. We now cover the wax with 40-gage tinfoil, place the guide in the mouth, and have the patient bite. The anterior inclined planes of the guide will direct the mandible to correct position. When this procedure becomes necessary, it is accomplished at the time the master impression is secured, as then all cavities in one arch are open; it being understood that the procedure could not be carried out if the temporary inlay or crowns were in place. When it is foreseen that it will be necessary to place the guide in the mouth to gain a relationship, it is best to construct it of metal. Wax will do as well for other cases.

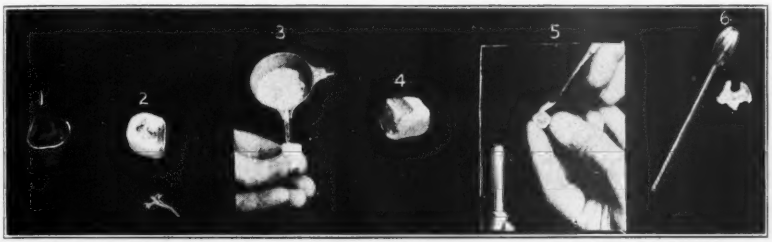

Fig. 7.—Low fusing alloy inlay for single tooth. *1*, band impression (or impression taken with compound in fingers). *2*, cast made with quick-setting plaster. *3*, adapting paper matrix and pouring alloy, which is pushed to place with finger. *4*, inlay as cast on plaster tooth. *5*, shaping with hot spatula. *6*, finishing burs and disks.

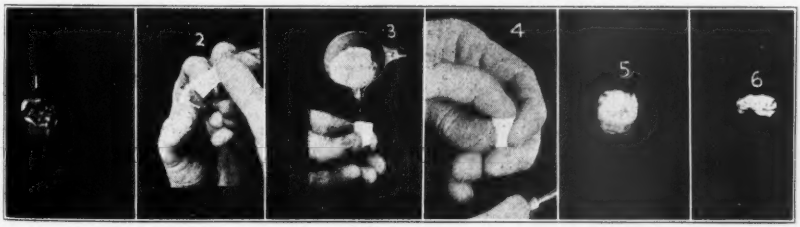

Fig. 8.—Low fusing alloy temporary inlays on copper amalgam dies. *1*, copper amalgam die. *2*, placing paper matrix around die. *3*, pouring alloy. *4*, casting with finger. *5*, inlay ready for finishing. This is always removed from die in cutting with burs and disks, to avoid scarifying dies. *6*, finished temporary inlay.

CONSTRUCTING THE OCCLUSAL POSITIONING GUIDE OF METAL

We burnish 60-gage tinfoil over the occlusal and incisal tips of the teeth on each cast, being careful not to contact

areas representing soft tissues. We let the tin extend across the palatal and lingual areas to facilitate directing the metal in the pouring operation. A drop of sticky wax placed at advantageous points on the buccal and labial surfaces will hold the tin in position when the articulator is closed to centric relation. A rope of slightly moist cotton is laid around the buccal and labial surfaces of the casts and held tightly in place with a wire loop. This is to seal the outer opening between the two pieces of tinfoil, so that the low fusing alloy can be poured from the palatal area between them. With a hot spatula, metal can be added or removed in finishing the buccal and the labial surfaces. With sharp curved scissors, we trim neatly to finish, and then lay aside the guide until the master casts are ready for mounting.

CONSTRUCTING THE OCCLUSAL POSITIONING GUIDE OF BASEPLATE WAX

We place together, by heating, sheets of baseplate wax, enough to fill the opening between the casts, cover with 60-gage tinfoil and trim to fit the arches; soften in warm water, place in position on the casts and close the instrument to centric relation. The wax should be softened sufficiently to permit closure of the articulator without forcing. When the centric position has been reached, the operation is complete.

STUDY OF CASTS AND ROENTGENOGRAMS FOR CAVITY PREPARATION

The operator has the advantage of visualizing the teeth in the exact position and relationship which they are to have in the finished case. This is a great aid in determining the type and extent of preparation. One of the important considerations when outlining the preparation is to lay margins on areas, which will insure that contours are finished with harmonious lines. Furthermore, we must keep in mind the fact that band impressions are to be taken and must be an exact reproduction of all marginal areas. This necessitates the correct extension of proximal walls to permit a soft copper band to make a close contact with gingival and proximal cavosurfaces; thus preventing the impression compound from flowing into the undercuts.

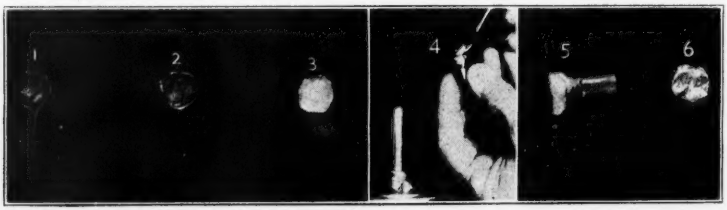

Fig. 9.—Low fusing alloy temporary crowns on copper amalgam dies. *1*, die wrapped with 60-gage tinfoil. *2*, tin trimmed and adapted to gingival margin. *3*, occlusal portion filled with alloy. *4*, spreading alloy over side walls with hot spatula, and shaping. *5*, crown ready for finishing with burs and disks. *6*, finished crown.

Steps and seats can be made very shallow when angles are cut sharp, particularly when a large area is to be covered by the inlay. The shallow preparation is well adapted to an indirect technic as closely adapted wax patterns can be secured even though very thin.

As designs are determined, they are outlined on the cast with a soft lead pencil or gold paint. The internal outlines of cavities are drawn with pen on roentgenograms by indicating depth of steps and seats.

The knowledge thus gained will enable the operator to cut with precision, deftness and speed, and the results of his careful diagnosis will be reflected in the finished product.

All preparations in one arch should be completed and the master model made and mounted before work on the opposite arch is begun.

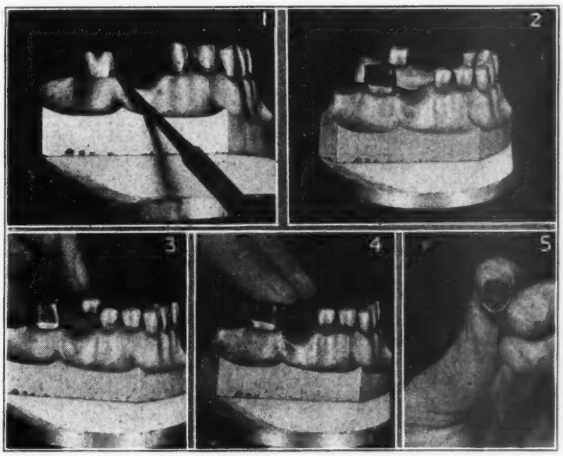

Fig. 10.—Band impressions for inlays. *1,* area, indicated by pointer, which must be closely adapted with band to prevent compound flowing into undercuts. *2,* soft copper band, correctly adapted. The band covers only surfaces parallel or convergent to cavity walls. *3,* compound heated to working consistency throughout and pressed into cavity. *4,* using finger to force compound to place. *5,* finished impression, which should exhibit a clean-cut impression of margins.

TEMPORARY INLAYS AND CROWNS OF LOW FUSING ALLOY

It has previously been stated that preparatory work is protected and the patient made comfortable at the dinner table with temporary inlays and crowns. This is a very necessary precaution when so many teeth are open, awaiting restoration. There are two methods of procedure for construction of the crown or inlay.

For immediate use, and in preparing a group of teeth at one sitting, it will be found efficacious to take an impression of all cavities at once, with compound in a crown and bridge tray. This is chilled well before removal. We make a cast with quick setting plaster, being very careful to fill without air pockets. By the time the operator has completed the band impression for the amalgam dies, the plaster cast will be ready. We simply wall off the interproximal area with a damp napkin, and pour at once with the low fusing alloy, which we remove and finish in one piece. It will be found very convenient to seal a group of teeth in this way. If working with a single tooth, we simply

take a piece of compound in the fingers, secure the impression and make a plaster cast, wrap a strip of paper around the tooth to form a matrix and pour the low fusing alloy. We cast by placing a finger over the metal to press it to place.

When making crowns for immediate use, we take an impression with compound in a tray, and pour with plaster. We section the tooth to be crowned out of the cast with a saw; let the gum line form a shoulder to create a space between the side walls of the tooth and the paper matrix; pour the low fusing alloy

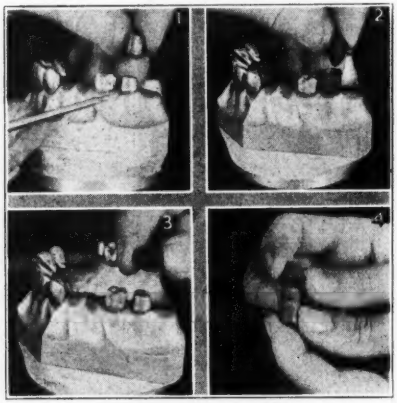

Fig. 11.—Impression for crown. *1,* soft 32-gage copper band fitted tightly and festooned to exact position crown is to occupy. *2,* band in position, to receive heated compound, which is forced to place. *3,* band affording impression of gingival margin and side walls, the compound taking only the occlusal impression and that of a small portion of the side wall. *4,* gingival margin of band showing as shoulder on die to be guide in waxing crown; which makes it possible to reproduce the gingival fit of the impression band in the finished restoration.

and cast with finger pressure, finishing with a hot spatula, carborundum disks and vulcanite burs.

The other method of producing a temporary case is to await construction of copper amalgam dies. Wrap paper around the die to form a matrix; pour low fusing alloy and immediately place a finger over the metal to be cast; remove and finish. Should a contact be loose, metal is added with a hot spatula to tighten.

We always remove the case from the die when finishing with burs and disks, to avoid scarifying the die.

In making low fusing alloy crowns or three-quarter crowns, we burnish 60-gage tin-foil over the die and trim to the margin; pick up the alloy with a concave spatula, and spread to correct thickness.

SETTING TEMPORARY INLAYS

Temporary inlays can be set with any good temporary cement, which would not make removal too difficult. Chloropercha is, to my mind, the material of choice, as it not only seals and holds well and permits the easy removal of inlays, but also has the added qualities of being easy to remove from the cavity. Pink guttapercha is used because it is readily distinguished from dentin. The dentin is dehydrated with chloroform, and wiped with eugenol, and the inlay spread with chloropercha, and forced to place. The surplus is wiped off with a cotton roll, and the operation is completed.

COPPER BAND IMPRESSIONS

Wax or compound should never be forced into a tooth until it has been protected against the forcing of débris into its tubulae. A safe method is to clean thoroughly, wipe with phenol and paint with resin in chloroform.

The band impression technic has been a very indefinite and indifferent procedure in the hands of most dentists. Perhaps this accounts for many criticisms of indirect technic. A common

error has been the use of loosely fitting or springy bands. The former permits the compound to flow into undercuts, distortion resulting at the buccogingival and linguogingival angles; which accounts for the fact that many castings fit the die perfectly, but present faulty margins when placed in the cavity. Furthermore, the loose band cannot be controlled when force is applied to adapt compound, and injury to soft tissues often results. The springy band will conform to the shape of the tooth when in place, but, when removed with the impression, it tends to assume its original shape. This accounts for the opening between the compound and band which often occurs. If the space is not present, many times the spring of the band has carried the compound with it. When a casting is made over a die from such an impression, we again have a flare at the gingival margin when the inlay is placed in the mouth. To secure accurate impressions, it is necessary to use soft copper bands which will assume and maintain the shape of the tooth. They should be tightly fitted to confine the impression material to cavity margins, thus not permitting it to flow into undercuts.

Another important point is to use just enough compound to fill the band. It should be heated to working consistency throughout. This will eliminate the defect which is occasionally seen on the occlusal margin of a die and which is the result of using a large cone of compound and only heating the point, using the hard base as a plunger.

IMPRESSIONS FOR INLAYS

A soft 32-gage copper band is fitted tightly, extending slightly beyond the gingival bevel and down to the height of contour on sound areas. With the band in position, just enough compound to fill it is heated to working consistency and the apex glazed and forced to place. The compound is then chilled with cold water. Impressions taken in this manner will come off with ease and give sharp definition.

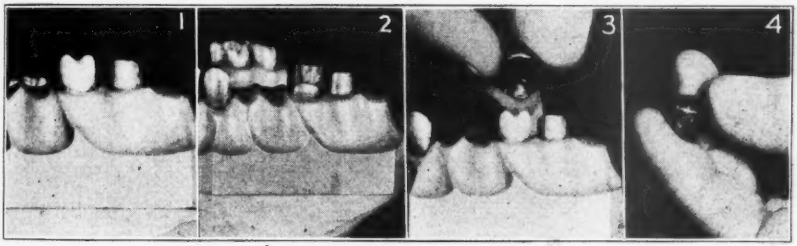

Fig. 12.—Impression for three-quarter crown. *1*, metal model representing patient. *2*, 32-gage soft copper band correctly fitted. *3*, compound placed in band ready to force to place. *4*, finished impression.

IMPRESSIONS FOR FULL CROWNS

For the full crown, a soft 32-gage copper band is fitted tightly and festooned to the gingival position the finished crown is to occupy. As the band is to be the gingival half of the impression, great care must be taken to fit this area accurately. Having completed the fitting, we remove, anneal and replace, and complete the upper part of

the impression with compound. When the die is made, the gingival margin of the band will show as a shoulder. This will be the guide in reproducing the gingival festooning of the impression band in the finished crown.

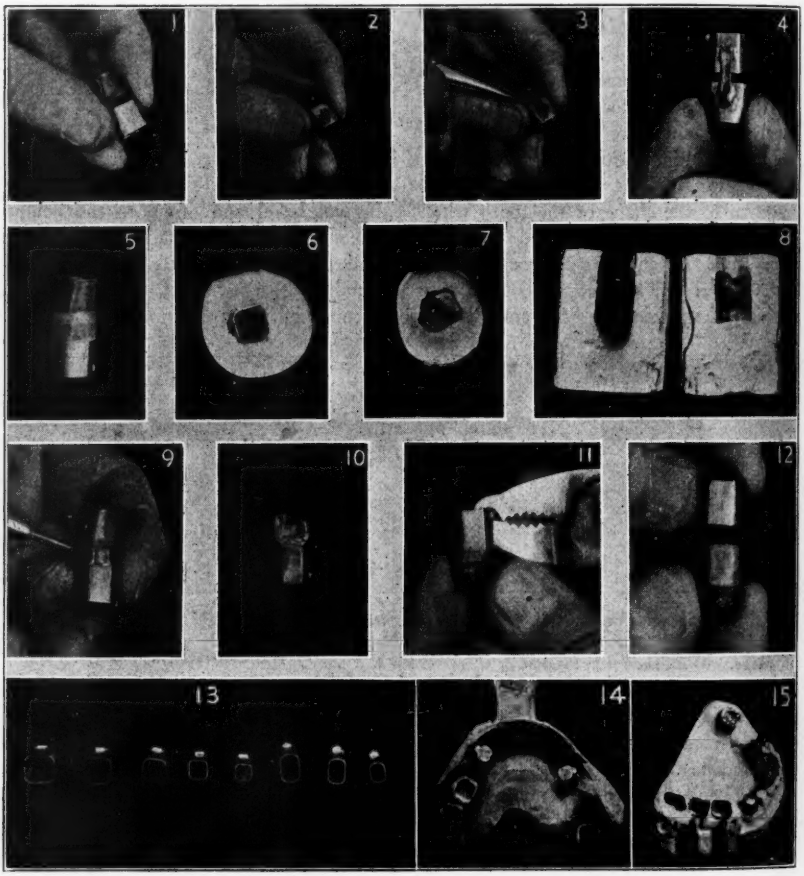

Fig. 13.—Construction of amalgam dies. *1,* method of positioning die socket and impression band. *2,* placing drop of sticky wax on socket and impression band. *3,* thin strip of metal, heated and placed as shown. *4,* die socket and band in correct relationship. *5,* space closed between socket and band with thin strip of wax. *6,* plaster investment. *7,* mold filled with copper amalgam. *8,* split mold after amalgam has set. *9,* smoothing amalgam between socket and band. *10,* finished amalgam die. *11,* removing die socket with die socket plier. *12,* finished die with die socket removed. *13,* die sockets. *14-15,* use of die sockets in construction of master cast.

IMPRESSIONS FOR THREE-QUARTER CROWNS

In securing this impression, it is easy to fit a band to be removed at one angle when the grooves dictate another, the resulting impression being distorted and a misfit.

It is well at this point to state that in securing an impression for a three-quarter crown, the band is filled with compound and forced to place, instead of being placed on the tooth and an attempt being made to force compound to place. The reason is obvious. The band is in such close proximity to the side walls of the preparation that the compound cannot flow to place. If the band is fitted carefully to cover all margins and the labial area so cut as not to cover undercuts, excellent impressions can be secured.

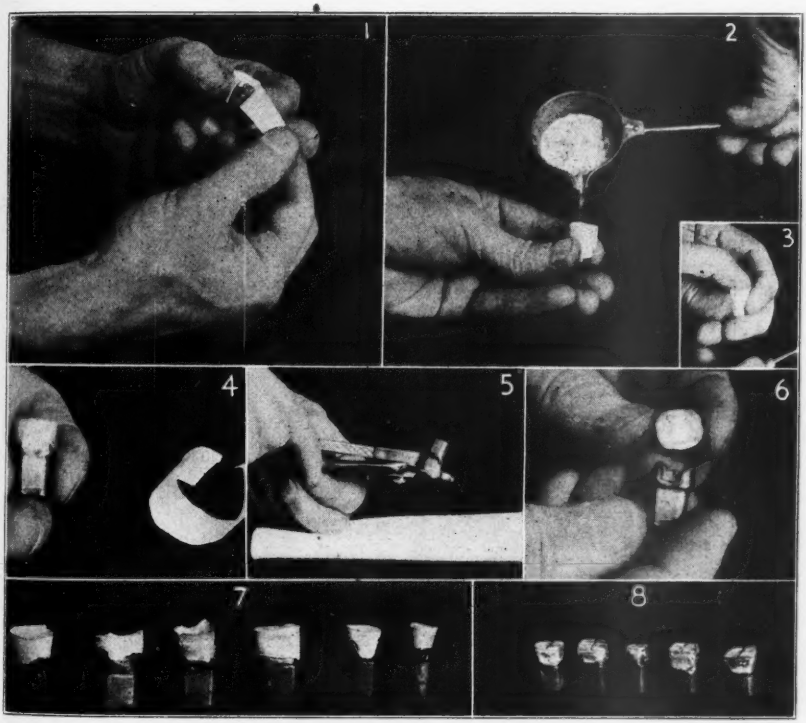

Fig. 14.—Construction of transfer inlays. *1,* wrapping paper matrix. *2,* pouring alloy. *3,* placing finger over metal and pushing to place. *4,* inlay immediately after molding operation. *5,* removing transfer inlay. *6,* large area transfer inlays should cover. *7,* transfer inlays as molded for combination compound-dentocoll master impression. *8,* transfer inlays presenting flat occlusal surfaces with sharp clean-cut angles, used in taking plaster master impression.

Impressions for three-quarter crowns, briefly stated, call for a 32-gage, soft copper band, trimmed to cover margins

and so cut out on the labial aspect as not to cover undercuts. The band is filled with compound, and forced to place and chilled. With sharp knife, the excess compound is trimmed to margins of the band before removal from the tooth. In case a perfect impression is not secured, it is best to remove the compound and start over as attempts at corrections seldom yield good results.

AMALGAM DIES

The root ends of amalgam dies are molded in metal die sockets, which later

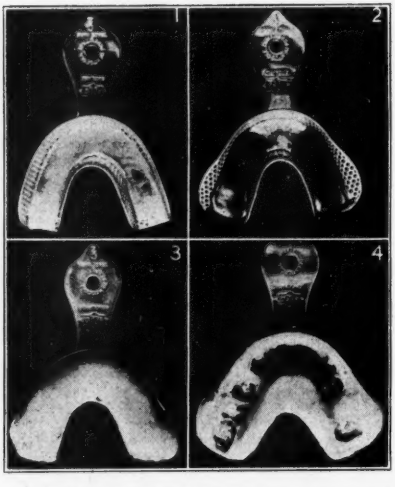

Fig. 15.—Combination dentocoll-compound impression. *1,* tinfoil fitted to floor of webbed tray. *2,* compound, black, placed over area which is to make contact with transfer inlays and crowns. *3,* dentocoll placed over softened compound. The tray is introduced into the mouth and forced to contact with the occlusal surface of transfer inlays and crowns. This is chilled for three minutes with cold water. *4,* finished impression with transfer inlays held in grasp of compound.

become their seats in the master cast. This not only saves the operator the task of tapering them by hand, but also gives a socket which, when accurately transferred to the master cast, will always provide for seating the die in its true position.

Copper amalgam is used for dies for the following reasons: Its volume is more constant than that of most silver alloys. Another reason for its use in this technic is that it permits the pouring of the alloy directly onto its surface without danger of drawing mercury. It is strong when properly worked, and offers the advantage of permitting the packing of a large number of impressions with a single mix. Furthermore, it can be used over and over again, which renders it economical.

Copper amalgam should be triturated and ground for several minutes, plenty of mercury being used, in order to assure a very plastic consistency. It is always placed on a cold slab before being introduced into the impression, since, if it is at all warm, it may distort the impression.

CONSTRUCTION OF DIES

A die socket, the approximate size determined by the gingival constriction, is positioned to the impression band and held in apposition by a flat strip of metal, secured to each band with sticky wax. The die socket should be parallel with the long axis of the tooth, at least 2 mm. of space being left between it and the impression band. The space is closed between the die socket and the impression band with a wrapping of thin wax. This is invested in a paper ring filled with thin plaster, one sixteenth inch of die socket being exposed to facilitate packing. Setting of the plaster should not be accelerated, as heat might distort the impression. Copper amalgam is used for filling, large pieces being pressed in the mold and jarred to place. When the impression is filled to the

top of the die socket, cotton is placed over the amalgam, which is pressed firmly and jarred thoroughly to condense the die. When the die is hard, the amalgam is disked smooth between the impression band and the socket. The die is thrown out of its socket with a die socket plier and is ready for construction of the transfer inlay.

FUNCTION OF TRANSFER INLAYS AND CROWNS

In order to gain a true transfer of dies to the master cast, it is necessary to have some definite way of knowing when they are accurately seated in the master impression. This is accomplished by constructing transfer inlays and crowns directly on the dies and

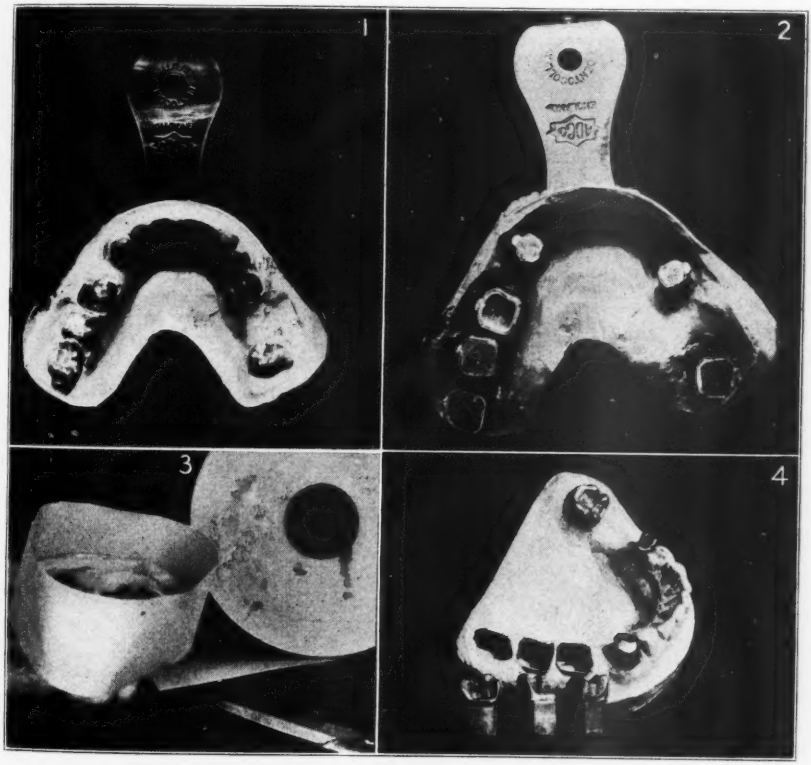

Fig. 16.—Placing dies in impression and construction of master cast. *1*, impression with transfer inlays in place. *2*, dies with die sockets in place seated in their respective inlays. The dentocoll is scraped to expose the compound on the buccal and lingual aspect of the dies, which are waxed firmly to place. The wax should extend up to the gingival margin of the die sockets. *3*, boxing with package sealing paper; cast poured with quick-setting stone. *4*, completed master cast. The die sockets have a coating of paraffin for lubrication. Slightly heating dies to soften the paraffin renders first removal from the master cast easy. The sockets and dies are cleaned with chloroform.

placing them in their respective positions in the mouth and securing an impression. The inlays and crowns will be removed with the impression. Dies with sockets in position are seated in their respective inlays and a stone cast is poured.

Transfer inlays should include all of the coronal areas which are parallel to or convergent with the walls of the cavity. They should never have interproximal contacts to interfere with seating. This is avoided in the molding by grasping the paper matrix mesiodistally to narrow it in this diameter and widen it buccolingually. Occlusal surfaces should be large and concave, with sharp edges on the band to facilitate the impression material's grasping and holding the piece firmly. This shape is assured when the finger is placed over the top of the paper matrix in pushing the metal to place. All transfer inlays and crowns should be of uniform height. This is accomplished by trimming the paper matrix the same above the occlusal surface of each die. The reason for having all approximately the same height is to permit the impression tray to come

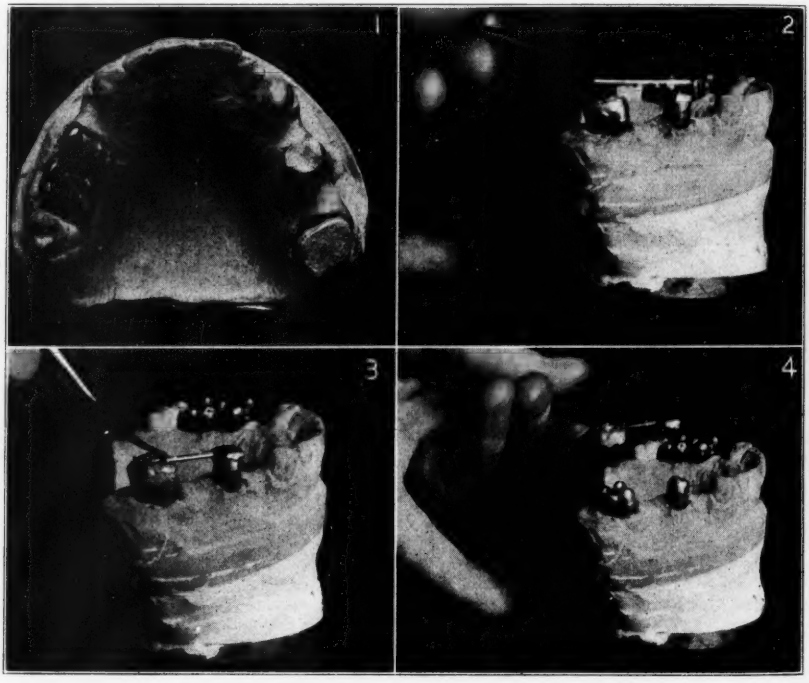

Fig. 17.—Checking bridge areas for accuracy of transfer. *1,* occlusal view of master cast showing transfer inlays in position on one side. *2,* stiff flat bar of metal heated and fused into inlays. *3,* alloy added with hot spatula, to make union firm. *4,* bridge removed from cast for trial in mouth. This is analogous to trying in the finished bridge and confirms accuracy of master cast.

in contact with them when the master impression is secured.

CONSTRUCTION OF THE TRANSFER INLAY

The paper matrix is wrapped around the die, which is held with the thumb and finger, causing pressure mesiodistally. The alloy is poured and immediately the finger is placed over the top of the matrix to confine the metal and force it to place. The ball of the finger causes a concavity of the occlusal portion of the inlay and leaves the band flaring and sharp. If the operation has been performed correctly, the inlay should be ready for use.

CONSTRUCTION OF THE TRANSFER CROWN

The die is wrapped with tinfoil, the occlusal surface being left exposed. The paper matrix is placed and the alloy poured, casting being accomplished with the finger. It will be noted that the metal only forms the occlusal portion of the crown, which has been given the proper shape. The tin covering the side walls of the die is now closely adapted by burnishing or swaging, removed and trimmed to the gingival outline, replaced and adapted. With a hot spatula, alloy is spread over the tin to stiffen.

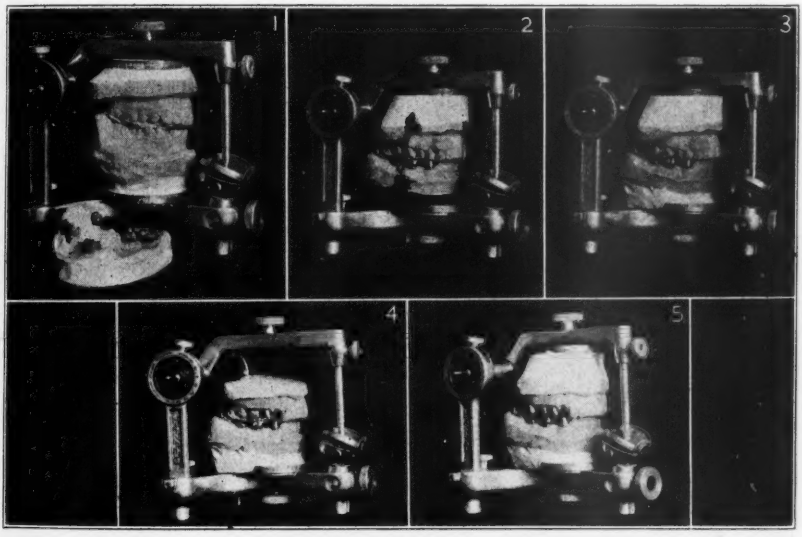

Fig. 18.—Mounting master casts with occlusal positioning guide. *1,* study casts in position of diagnosis with occlusal positioning guide in place; mandibular master cast ready for mounting. *2,* study cast removed and master cast occupying its position. *3,* mandibular master cast mounted in position of diagnosis. *4,* maxillary master cast occupying position of upper study cast in occlusal positioning guide. *5,* master casts occupying position of diagnosis and ready for completing case at this time. The incisal guidance is set for the correct cusp height of the case in hand.

The same technic is used for three-quarter crowns, with the exception that the part of the tin which covers areas not in the cavity is trimmed to the height of the concavity to avoid undercuts.

The inlays and crowns are positioned in the mouth and an impression is taken.

is probably the surest of all when scientifically manipulated. In the hands of the majority of dentists, it is very difficult, especially to take impressions of cases which present many irregularities caused by tipped teeth and edentulous areas. Too often, just the piece is lost which would complete an otherwise good impression.

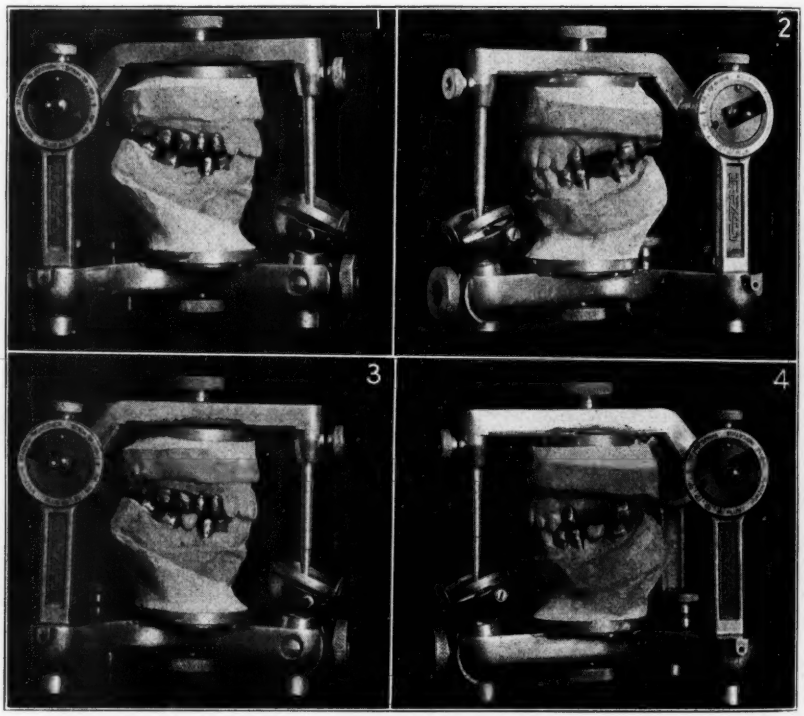

Fig. 19.—Constructing case. *1*, right view of master casts. *2*, left view of master casts. *3*, right view after building up with wax. *4*, left view. The pontics are built along with the patterns.

DESCRIPTION OF THE MASTER IMPRESSION

There are several methods of taking impressions which are accurate when properly handled. The plaster method

Owing to the difficulty in the use of plaster, I have developed an impression technic, which is giving excellent results and is easy. A combination black compound and "dentocoll" is employed.

TECHNIC

A strip of 60-gage tinfoil is fitted to the floor of a webbed tray. A thin roll of black compound is heated to proper consistency, at the same time that the dentocoll is being prepared. The tray is heated and compound placed over the tin foil, and at once filled with dentocoll over the compound. Immediately, this is introduced into the mouth and the floor of the tray is pressed to contact with the transfer inlays. It is very important to seat the floor of the tray in order for compound to displace the dentocoll and grasp the inlays firmly. Chilling with cold water for three minutes makes the compound hard and brittle. The dentocoll, of course, remains elastic. The impression is removed. It will be noted that the compound shows through the dentocoll, and has taken only the impression of the metal inlays and occlusal surfaces; the balance of the impression having been taken in dentocoll. Usually, the metal fittings will be held firmly in the grasp of the compound. If they have been displaced, they can be reseated accurately.

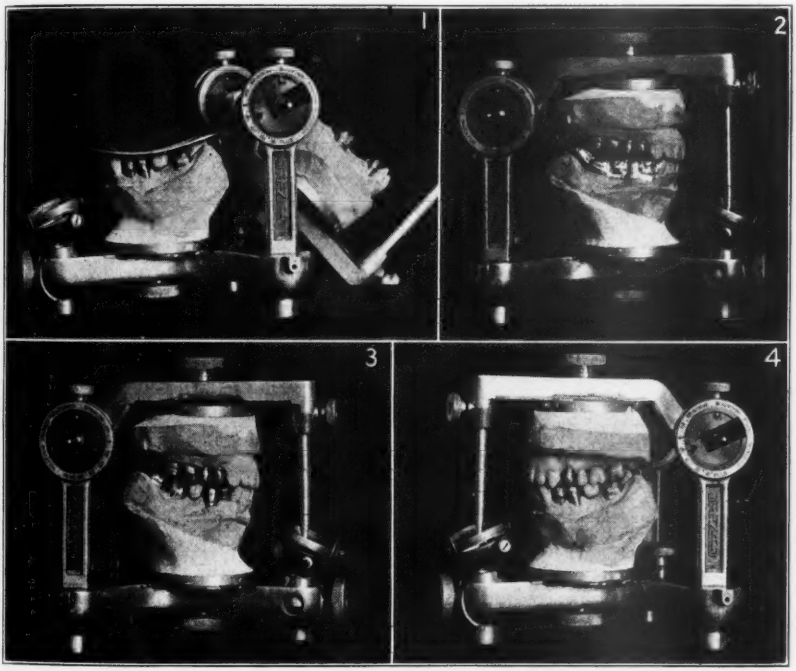

Fig. 20.—Constructing case. *1*, use of template in establishing compensating curve. *2*, lower patterns covered with thin tinfoil and lubricated with cocoa butter. *3*, right view with patterns completed. *4*, left view with patterns and pontics in wax.

SEATING THE DIES IN THE IMPRESSION

The dies, with the sockets in position,

are pushed to place in their respective inlays. When the dies, with sockets in place, are all in position, they are ready to be waxed firmly to place. As wax will not adhere to dentocoll, it is best to expose the compound toward the buccal and labial aspect of each die and fill in with wax, entirely covering the exposed coronal surface of the dies up to the margins of the die sockets. This will hold them firmly in their seats and at the same time prevent the cast material from covering the undercuts and making their removal difficult. The impression is boxed and run in quick-setting, hard stone. To separate the impression from the cast, the floor of the tray is heated sufficiently to release its grasp on inlays, and removed.

FIRST REMOVAL OF THE DIES FROM THE MASTER CAST

Die sockets have a coating of paraffin for lubrication, which should not be removed until this stage. Slightly heating the dies to soften the paraffin renders their first removal from the master cast easy. The sockets and root end of the dies are cleaned with chloroform to remove the paraffin.

CHECKING BRIDGE AREAS FOR ACCURACY OF TRANSFER

Checking the bridge areas for accuracy of the transfer is accomplished by making a bridge of the transfer inlays. A stiff flat bar of metal is heated and laid on the inlays on either end of the bridge space, and, with a hot spatula, sealed tightly. Thus, a provisional bridge is obtained. This is removed from the cast and tried in the mouth for seating. This check is analagous to trying in the finished bridge. If the transfer is correct, perfect seating will be accomplished with ease. If the transfer is faulty, this is the time to correct it.

MOUNTING THE MASTER CASTS

We have stated that once the study casts are mounted in the working position, and an occlusal positioning guide is made, no further registration of centric occlusion is necessary from the patient. The master model, being completed, is placed to position in the occlusal positioning guide, and mounted to the opposite study cast.

CONSTRUCTION OF THE CASE

Master casts containing dies of all teeth to be restored have been mounted and the articulator adapted. The incisal guidance now becomes a guiding factor in coordinating the occlusal surfaces on a compensating curve, which will be in harmony with the movements of the mandible. The anterior-posterior plane has been set to the correct overjet, and the lateral tables have been adjusted to produce cusp height, to fit the age of the patient. The vertical height between the arches has been increased and the consequent space is to be occupied with the inlays or crowns. In most cases, it is good mechanics to divide equally the spaces between the arches. This distributes equally the lateral stresses, which have been increased by the additions to the vertical length of the crowns. Any rule in connection with establishing the compensating curve must be flexible, as the type of case being treated will be the deciding factor. Building up occlusal surfaces in worn and mutilated cases is a compromising operation. If good margins, well shaped tight contacts, and properly designed occlusal surfaces are provided and coordinated with the movements of the mandible, good results will be obtained.

All dies are lubricated with cocoa butter and building of the wax pattern of the lower arch is begun, establishing the

occlusal surfaces on the curve to be given the case. It must be kept in mind that the lateral curve is just as important as the anterior-posterior. A template will assist in giving the correct design. The occlusal surfaces are carved, the cusp height being established as planned. If the form to be given the opposing teeth is visualized, the designing of the occlusal surfaces will be done with forethought, and the intercuspal relationship of the final waxing will be simplified. If bridge areas exist, pontics are built along with the waxing operation. When patterns in the lower arch are completed, they are covered with thin tinfoil, well-adapted, thus protecting the carvings and giving a metal surface to mold the opposite patterns against. The tinfoil is lubricated and the waxing begun in the upper arch. A first molar is constructed to form, the occlusal portion softened and carefully closed to centric relation. This will mold it to fit the lower carvings and be a starting point for finishing a correctly designed occlusal surface. This procedure is continued until all are completed. The tinfoil is removed from the lower wax. Now we carefully reproduce the movements of the mandible, to sheer the wax, in harmonizing the occlusal surfaces, to the dictation of the incisal guidance. When the best possible coordinated occlusion has been established, we are ready to cast the patterns of one arch.

The operator now has the advantage of the finished lower to work against in perfecting the patterns of the opposing arch. When the teeth are all in place on the instrument, they are spot ground until the guidepin follows the incisal guidance without interference. The case is now ready for adjustment in the mouth.

No matter how carefully each step has been checked, there will be contacts to be adjusted, and occasionally tension in a bridge to be corrected, and always a final adjustment of the occlusion.

1124 Republic Building.

The Journal of the American Dental Association

212 East Superior St., Chicago, Illinois

C. N. JOHNSON, Editor

Published by the American Dental Association

All expressions of opinions and all statements of supposed facts are published on the authority of the writers over whose signature they appear, and are not to be regarded as expressing the views of the American Dental Association, unless such statements or opinions have been adopted by the Association.

Communications intended for publication in the scientific or literary pages of THE JOURNAL should be addressed to the Editor. All advertising or business matters should be sent to the Business Manager.

Subscription is included in the annual membership dues. To nonmembers living in the United States or its possessions, the price is $2.50 a year in advance; Canada, $3.00; Australia, $4.00; other countries, $3.25. All foreign subscriptions are to be paid in United States money.

Editorials

THE REAL FUNCTION OF DENTAL PHILANTHROPY

During these latter days, we have been obliged to think much about philanthropy. It has come to our attention from many angles, and in various guises. Mostly, it has confronted us in the regular order of things whereby society seems constantly to be slipping a cog and letting the machinery of life grind a bit harshly and fail to function properly. In other words, there always seem to be people among us who are so ill adjusted to their environment that they are never able to make ends meet and are dependent on charity of some sort. Why this is so it is difficult to understand. In America, there really should be no excuse for charity short of some kind of calamity such as physical incapacity or accident. Yet daily we are confronted with cases calling for outside aid where there is no illness or accident, where the even tenor of our lives, if there is such a thing, should run along with sufficient functioning to provide food and raiment for everyone. Something

is wrong somewhere, and the thing that is wrong is occupying the minds of many of our ablest reasoners.

Born as humanity is, some of this lack of adjustment in our social and economic fabric seems inevitable, but the question is, how are we to be born better? That is a leading question and has been ever since humanity had a history. Reams have been written on eugenics, but the problem is not solved yet. Many of the fine-spun theories of eugenics seem bootless in the face of human nature and animal impulse. The happy-go-lucky instincts of most of humanity run riot over the cold reason of our philosophers and the result is too often bedlam.

The natural question is, what are we to do about it? In the existing state of civilization, or lack of it, some of our present human imbalance appears to be without remedy. It will require the wiser brains and farther seeking of future civilizations to solve the problem of a real regeneration, but this should not be construed as a tacit acknowledgment that today we can do nothing about the situation. Something we can do, and something we should do, and this has a direct bearing on our dental philanthropy.

We no longer need to demoralize society by a false standard of philanthropy as we have too frequently been doing in the past. It does not help matters to realize the fact that, for the most part, we have been doing this with the best intentions, and in the goodness of our hearts. Goodness of heart does not change a wrong into right, or remedy a definite evil. To go more directly to the point: We have been doing harm to the objects of our charity by assuming an obligation that, strictly speaking, belongs to the individuals themselves. It is the easiest and most natural thing for generous people to want to lend a helping hand to those in trouble or distress, and it is one of the noblest impulses of humanity to do this. But, in our generosity, we have frequently waived the wisdom that should always accompany it. We should use the same judgment in dispensing charity that we do in other enterprises of life; we should study cause and effect.

And here is one of the effects that we should face at once:

The moment an able bodied man reaches out a hand and accepts something for nothing, that moment a moral disintegration begins in the man as inevitably as there is an effect to a cause. We have been doing a definite wrong and working irreparable injury in some of our dental clinics by indiscriminate charity. There is no need to remind us that there are numerous cases where outright aid is imperative. Illness and childhood make their legitimate and proper appeal to us, and we trust that the dental profession may never be found wanting when the call for succor is worthy and manifest, but the moment the illness is cured and the children become adults, they should be faced with their legitimate responsibilities.

Let us mix sanity and wisdom with our philanthropy and guard the manhood of those we would aid, and we shall thereby avoid much imposition, and encourage the development of character and independence among the masses. The best philanthropy and the most potent help is to induce people to help themselves. Individual responsibility and independence of character are real and tangible virtues, and woe betide the one who flouts them or tries to escape them.

The moment that we dispense dental charity without discrimination, we at once introduce the idea in the minds of the objects of our charity that there is a definite obligation on our part to deliver dental service without recompense, and this idea is demoralizing in every way, most of all to the recipients of the free service.

The dole of England, necessary as it may have been as an emergency measure, has done more to break down the morale of the British people than all of the suffering entailed by the war, and surely there was suffering enough.

Pauperism is somebody's crime—whose particular crime we are not at this time suggesting—but let us at least not contribute to this crime by fostering a spirit of false philanthropy and delivering dental service to the people without discrimination. The real function of dental philanthropy is to see that suffering is relieved, that little children are cared for and, after this, that

every object of charity shall be made to realize that some kind of recompense is in order, however small it may be. Something for nothing is bad psychology and false ethics.

THE OPPORTUNITY OF THE DENTAL SCHOOLS

At each opening session of our dental schools, there comes an opportunity for real service to dentistry through the medium of the proper influence that may be exerted on the student body. This influence must manifestly come from the teachers in our schools, for no matter what the basic policy of the school may be or how well grounded in ethics the management may become, it is the daily contact between teacher and student that makes the greatest impress on the student body. It would be the strangest thing imaginable if students working daily under an instructor were not profoundly influenced by the latter. This relates not only to the technical knowledge that he imparts, which naturally at once makes an especial appeal, but in a deeper and more significant sense, it may well affect the entire professional fabric of the embryo practitioner.

These young men and women are in the formative stage of their life work. For the most part, they are amenable to wholesome influence and worthy example. Few of them will ever be found flouting advice if it is given in the right spirit, and therefore the ethical approach that is made between teacher and student is most important. In a very real sense, the students are in the hands of their instructors as far as ethical influence is concerned. It is therefore of the utmost moment that the teachers themselves be imbued with the highest possible conception of ethics.

Not that the instructor shall forever be prating about ethics or moralizing among the student body; in fact, it would sometimes seem that the less said the better; but that the daily and hourly example set by the teacher shall be of such a character that perforce the students are impressed by it and intuitively led

along ethical lines. The idea of professional ethics should be woven in the warp and woof of every individual student. If it is true that "no stream can rise higher than its source," it is vastly important that the constant stream of our educational influence shall be purified at the very beginning of the professional course. The fundamental distinction between professional life and commercial life should be emphasized by the difference in demeanor between the student body and the business world; and the occasional—sometimes the prevalent—tendency that we see cropping up to the effect that "after all, dentistry is a business" should be frowned on in no uncertain way. A clear distinction should be impressed on the student's mind between the ethical conduct of a professional pursuit and the too fervid following of commercial methods in a dental practice.

This does not mean that sane business principles shall not be taught to students, but that the emphasis shall be placed on professionalism rather than on commercialism. Students should never be permitted to forget that they are dealing with human beings instead of with inert commodities, and that there is a vast difference in the obligations involved in each case.

Our dental teachers have a definite and pronounced responsibility not only in imparting a knowledge of the science and art of dentistry, but as well in directing the minds of the students along those lines that shall make for the highest and most exalted conception of ethics and correct living. The teacher who thinks of nothing but the training of students in technical procedures and in the science of dentistry, to the sole end that they may succeed in passing their examinations and qualify for their college and state board requirements, is not fulfilling his true function as an instructor. Through every agency in his power, he should seek to so instil in the student mind the essence of professional manhood that, when the graduate goes out to meet the world, he will make an impression on those with whom he comes in contact as a member of an honorable calling with a social status equal to any. "Culture for culture's sake" as an ethical concept has made an appeal to many teachers who have been

proclaimed impractical, but culture in professional life need not be dubbed impractical. As an attribute of daily living, culture is a real and tangible asset.

AN EDITORIAL POLICY FOR DENTAL JOURNALISM

There is often a difference of opinion as to what the editorial policy should be in a professional journal. Manifestly, the editorial aim should be to do the greatest good to the greatest number. The body of the publication should consist of articles prepared by professional men pertaining to the science and art of the calling, most of which, of course, consist of papers read before societies together with their discussions.

In another section of the journal, there should be news items pertaining to professional activities, such as notices of meetings. Correspondence is also admitted when it treats of questions pertinent to the profession. Departments should be encouraged dealing with some particular activity of interest and import to the profession. Abstracts may be made of articles appearing in other publications which seem of significance.

This leaves the editorial department, and it is in this department that differences in policy are most likely to arise. As we interpret it, the chief function of an editor is not to fill the editorial pages with dissertations on scientific subjects. An occasional topic of this character may be treated editorially, but, for the most part, the science and art of the profession are abundantly considered in other parts of the publication. In these other parts are treated all of the research, all of the technical advances, all of the scientific speculation.

When it comes to the editorial pages, they should deal with matters of policy in the profession, with legislative affairs as they pertain to the welfare of the profession and the people, with noteworthy advances in the profession, and with the general welfare of the profession as a whole. It is the legitimate field of the editor to check in his pages any pernicious tendencies that may develop

in the profession, any ulterior influences that he may see arising on the part of groups in the profession or out of it, and to safeguard as best he may the good name, the general reputation and the recognized and honorable status of his calling.

It would be tantamount to egotism for an editor to fill his department with dissertations on the various scientific phases of his profession, matters that are extensively dealt with in other departments of his journal. No one man, least of all an editor, has a monopoly on all the scientific lore of his calling, and it would be the essence of presumption for him to assume that he could write intelligently on any appreciable number of the scientific subjects that concern the profession. Nor would it be his legitimate function to attempt to do so. For the editor to write in his department on the various abstruse topics that concern the profession would be merely to make himself ridiculous, and to lessen his influence, and the influence of his publication.

All editors that we have known have made mistakes—it seems to be inherent in the editorial nature—but if all the editors that are at present serving the profession in this capacity were displaced by an equal number of those who are assuming to tell the editors what they should do, it is conceivable that there would be just as many mistakes as there are now. Mayhap there might be a few more.

VOTE

Of course this is not a political publication, but it goes to more than thirty thousand of the intelligent men and women of this nation. And this nation needs intelligent thinking if ever it did. Manifestly, we hold no brief for either candidate or either party, but we make an almost impassioned plea that the dentists of this country think soberly, seriously and intelligently on the issues of the day and vote accordingly at the coming election. Our great fault as a nation and as individuals is indifference. When any issue affecting the welfare of the nation is presented for decision, the voters are too much inclined to say: "Oh, what's the use—let

George do it." And accordingly George does it—the George in this case being represented by the ward heeler and the political parasite. He votes.

What a howl we send up at some of the legislative enactments of our representatives, and, as a matter of fact, how pernicious are some of these same enactments; but we seem to forget the fact that we elected these representatives by our votes or by our failure to vote, and are thus responsible for the bad legislation. If, as sometimes happens, our representatives play traitor to the principles for which we elected them, the matter should not end there as it usually does. The citizen should take cognizance of the votes cast and hold his representatives accountable for their legislative acts. Eternal vigilance is the price of good government, and it behooves professional men and women, who are supposed to have the mental capacity to think logically on any question, to devote themselves to a study of the issues of the day and vote for the betterment of society. Indifference is almost as great a crime as stealing sheep; in fact, it may do more harm. Indifference is sometimes classed as a minor dereliction, but it may well become a major sin, and to neglect to safeguard the welfare of the commonwealth constitutes itself a positive wrong.

Study the caliber of some of the men who make our laws, and then consider the fact that they were elected by the people. A stream can never rise higher than its source, and we shall never have better laws till we elect better men. This country, with a heritage as fine as ever was vouchsafed to any people, has been shamelessly exploited at the hands of a lawless and irresponsible element, till there has developed a serious strain on the stability and good name of the commonwealth. It has so far withstood the stress of ulterior influences, but how long it can survive without a tightening up of the consciousness of the people remains to be seen. It should not be put too much or too long to the test.

We are prone to recite the fact that Rome, the imperial city, fell when it was at the height of its glory, and we are also told that its fall was due to the same tendencies that we see manifest so widely today. All of this may be true, but history does not always

repeat itself, and traditionally we are not as the Romans were in the days of their downfall. The same regeneration that we see taking place today in Rome can come to America, and it can come without the shedding of a drop of human blood. Peaceful means, through exercise of the franchise, may regenerate America and make this fair land of ours blossom like the proverbial rose.

Make no mistake: this coming election is a serious matter. Every election now for years will be a serious matter, because in these elections will be formed the crucial test of our citizenship. It is not a question of party affiliation, but a question of consecration to duty. Think the situation through and then vote according to your convictions, but by all means vote. Not to vote at an important election is to announce yourself a slacker, and a slacker is known to be a very undesirable person. It is as much a duty to vote as it is to obey the law, and the obligation to obey the law is fundamental. No dentist with a spark of manhood in him will ever shirk so manifest and so simple a duty as that of voting, and the time is none too long in which to study the various issues in the coming election, to the end that intelligence may mark the casting of the ballot.

RELAX

It is a mistake to keep keyed up all of the time; the tension tends to snap something after a while. In the stress and strain of modern life, there are times when it seems necessary to concentrate on the problems of our existence and to use every atom of our energy to accomplish the purpose set out for us; but there is no problem so grave that it will not permit of an occasional surcease and a period wherein we may let go the threads for an instant to take breath. It is a marvelous achievement to learn how to relax and to yield oneself up to an utter abandonment of all that is stressful. To relax is to let the blood flow easily through the tired vessels so that they may regain their tone and pulsate normally. To keep under continual tension is to strain the structure and wear out the machinery long before its time. We hear in the human organism

of fatigue poisons in the tissues from the prolonged and unusual tension, and in these days of extraordinary stress, we need to guard against an accumulation of too much poison, which must inevitably clog the secretions and impair the entire organism. Learn to relax—even to compel yourself to relax, as difficult as this may appear. A little philosophy in the matter may help, and even if it requires much philosophy, we should school ourselves to it because of the vital need that each individual has of letting completely down at times and renewing his energy through rest.

ARTHUR G. LOOMIS, D.D.S.

(1881-1932)

ARTHUR G. LOOMIS, D.D.S.

Arthur Garfield Loomis died at Mount Baldy, Calif., August 13, after an illness of several weeks, the primary cause of death being acute dilatation of the

heart. Death was entirely unexpected as he had appeared to be improving daily in the higher altitude to which he had been moved from his home in Glendale.

Dr. Loomis was born in Flint, Mich., March 4, 1881, and here he completed his high school education at the age of 17. He early showed a bent for music, studying piano, violin and voice. In September, 1905, he entered the Northwestern University Dental School, from which he was graduated in 1909. Thereafter, he practiced in Chicago for fifteen years. He was one of the first editors of the *Chicago Dental Society Bulletin,* and, in this connection, Dr. Johnson wrote of him, in the issue of April 18, 1924:

"Coupled with his ability as an editor, there is another phase of his character which it seems perfectly proper to mention at this time. In addition to being unbiased in his editorial policy, he was lovable in his demeanor toward his associates—toward all men, in fact. How much our organization owes to Arthur Loomis for harmony in its ranks will never be known. As a friend, he stands forth in full effulgence. To know him, to counsel with him, to visit with him, is a broadening of one's friendly horizon. Wherever he goes, he will make friends and he will keep them. California is fortunate in the acquisition of this man. It will be a better state because of his residence in it."

And while Dr. Loomis adopted California from the first, loving it for its innumerable charms and natural scenic beauties, he never quite became reconciled to the separation from his many Chicago friends and the "boys" in that great and broad dental fraternity whom he had left behind.

In his professional work, Dr. Loomis was interested chiefly in the perfection of detail and the artistic development of the mechanical side of dentistry. For the past two years and a half, he had been evolving a casting machine. This he had finally perfected and, in its elasticity of scope, it promises to be a valuable addition to the dentist's armamentarium.

Life is not length, but breadth. It is not how long a life we live, but how broad, useful and full a life. Measured in years, Dr. Loomis' tenure of life was short, and though long life was denied him, he had lived fully and usefully, and therefore his life was successful and complete.

RALPH W. BECKER.

COUNCIL ON DENTAL THERAPEUTICS

DIET AND THE TEETH

By FRANKLIN C. BING,* Ph.D., Cleveland, Ohio

The Council has authorized publication of the following report prepared by Dr. Bing at the invitation of the Council, as one of its series of articles on pharmacology and therapeutics.

SAMUEL M. GORDON, *Secretary.*

The causes of dental caries, and methods for its prevention, have baffled scientists for many years. Since the time of Miller, who advanced the first explanation for the local causes of caries, continued investigations have left the problem still unsolved. With the recent advances in the science of nutrition, attention has been diverted to the possible rôle of foods in the etiology of dental caries. According to the evidence now available, tooth decay may be largely arrested or prevented by simple dietary measures. It is not known whether the favorable results obtained with dietary treatment are due to alterations in the local environment of the teeth or to slight systemic changes such as might lead to increased resistance. Theories regarding the mechanism of tooth decay and its prevention lie outside the scope of this report. The present article summarizes the important data pertaining to the relation of nutrition to dental caries. This question, as well as that concerning the actual processes of dental disorders, has been the subject of numerous recent reviews.

The extensive experiments reported by Bunting and his collaborators at the University of Michigan may be taken to illustrate the effect of diet on the teeth. Five communities of children were examined over periods of from nine months to one year. One group of 159 children received adequate food, but no special therapeutic treatment. At the end of a year, 75 per cent showed arrested development of old caries and complete freedom from new lesions. A second group, numbering 104 children, was given a mouth wash containing hexylresorcinol each school day for nine months, but no dietary control was exercised. Only 25 per cent failed to develop new caries in the period of study. A third group, receiving neither dietary nor therapeutic treatment, in one year showed only 18 per cent protection from caries. Some institutional children were given a mouth wash containing hexylresorcinol in addition to a controlled diet. At the end of one year, 218 out of 274 cases were free from further caries, only fifteen had developed active decay and forty-one had slight or questionable caries. In reporting this reduction of dental caries to a minimum in 433 children, the authors concluded that the fundamental factor was the improvement of the diet.

*Instructor in Biochemistry, School of Dentistry, Western Reserve University.

These data are discussed in some detail because a proper evaluation of the conclusions drawn from statistical observations on human subjects is possible only by a critical examination of the experimental procedures that have been used. Dentists will recognize that a period of one or even two years represents only a very limited time in the study of the decay of human teeth. Conclusions drawn from short-time studies may be subject to revision. Bunting's observations on the prophylactic effect of diet were controlled simultaneously by a study of similar but separate groups of children of the same age who received no treatment. Such controlled observations possess distinct merit.

Other data support the view that the progress of dental caries in both children and adults can be checked by the eating of the proper foods. Among the more extensive reports may be mentioned those of Mellanby in England; Boyd, Drain and Nelson in Iowa City; Hanke in Chicago, and others. It is recognized, of course, that there are factors other than nutrition in the control of caries. The above-cited experiments, based on a fairly large and representative number of persons, mostly children, support the view that dental caries may be considered a dietary deficiency disease. This is peculiarly significant because of the ease with which preventive treatment by means of diet may be instituted. In conjunction with data on the incidence of caries in the United States, the conclusions drawn from nutritional studies imply that the complacent attitude of many persons with regard to the adequacy of the "average" American diet may be wholly unfounded. The food we eat may not be wisely selected from the newer standpoint of the requirements for good tooth formation and preservation.

Although the importance of nutrition in dental hygiene is now commonly recognized, there is considerable difference of opinion as to which particular dietary ingredient is responsible for the beneficial effects. Some investigators emphasize the rôle of vitamin C; others prefer to hold vitamin D responsible for the favorable results; some say it is the calcium: phosphorus ratio of the diet; still others stress the ingestion of foods having an alkaline ash; a few claim it is due to the avoidance of sugar, and there are those who have little preference, but speak of a "well-rounded" dietary.

In order to interpret the benefits of the nutritional treatment of dental caries, or to formulate actual menus with something more than rule-of-thumb as a guide, it will be necessary to examine and to evaluate the experimental evidence.

EFFECT OF CALCIUM, PHOSPHORUS AND VITAMIN D

The teeth are composed largely of inorganic salts, and it is not surprising that early experiments should have considered the effect of calcium, phosphorus and vitamin D on their development. The well-known investigations of Sherman have stressed the fact that the ordinary American dietaries may be deficient with respect to calcium and phosphorus. This is particularly true in early childhood and during pregnancy, where mineral deficiencies in the diet of the mother probably account for the old adage of "a tooth for every baby." It remained for Mrs. Mellanby to begin the study of the effect of an abnormal calcium and phosphorus metabolism, such as is present in rickets, on the structure of the teeth. She first showed that the teeth of rachitic puppies were late in erupting and were irregularly

set in a malformed jaw. Blum and Mellion have likewise reported that the eruption of the first tooth, and subsequent deciduous teeth, is delayed in rachitic infants.

Although the teeth of Mrs. Mellanby's experimental animals were soft and deficient in minerals unless cod-liver oil was administered, it does not appear that any cases of active caries were ever observed. This may have been due to the anatomic structure of the dog's tooth, or the length of time of the experiments, or to an immunity of the species to caries. It was believed that the defective structure might easily lead to bacterial attack and then to extensive and rapid decay. The fact that the teeth are adversely affected by the abnormal calcium and phosphorus metabolism characteristic of experimental rickets has been amply confirmed.

Mellanby, Pattison and Proud applied the results of their animal experiments to the feeding of children in a home. All the patients were between 5 and 12 years of age, and all suffered from tuberculosis of the bones. The children received their usual rations, but additional substances containing the antirachitic factor were fed to some. The results indicated that with irradiated ergosterol, milk, eggs or cod-liver oil there was less caries initiated or less increase of caries. These experiments have been criticized because the children were either suffering from a disturbance of calcium and phosphorus metabolism or were otherwise not in good health.

Additional experiments were later performed with normal children averaging about 9 years and 4 months of age at the time of the first examination. All the children received the ordinary institutional diets of English orphanages, and were fed in addition either molasses (eighty-five cases), olive oil (sixty-five cases) or cod-liver oil (eighty-six cases). In two years, the increase in the percentage of carious teeth was, for those receiving molasses, 10 per cent; for those receiving olive oil, 8 per cent, and for those receiving cod-liver oil, 3 per cent. Further experiments, in which olive oil containing irradiated ergosterol was administered to one group, were made. From both studies, it was concluded that caries was significantly retarded by vitamin D therapy.

Jones, Larsen and Pritchard have reported that although rickets is rare in Hawaii, owing to the large amount of sunshine, dental caries and other tooth defects are common. Friel, Irel and Shaw have pointed out that rickets is also practically unknown in South Africa; yet 93 per cent of 600 children examined in Johannesburg had one or more carious teeth. The average for all children was 4.8 carious teeth each.

Hess and Abramson have concluded, from a study of the incidence of caries in relation to the amount of sunshine in various parts of the earth, and from an experimental study of the teeth of children who had developed rickets in infancy as compared with the teeth of normal children, that vitamin D is not the primary factor in the production of dental caries. It would seem, therefore, that while vitamin D is vitally concerned with the metabolism of calcium and phosphorus, and hence with the formation of bones and teeth, there may be other dietary principles that play a possibly greater rôle.

The recent work of McCollum and Klein, who have investigated this problem from a somewhat different angle, may explain the conflicting reports

in the literature. Their experiments show that caries may develop in rats having no symptoms of rickets, if the calcium : phosphorus ratio of the diet is sufficiently high, the proper ratio being estimated at about 3 parts of calcium to 4 parts of phosphorus. That a relative phosphorus deficiency is responsible for caries in rats has been denied by Hoppert, Webber and Canniff. The diet exerts its effects, according to Klein and McCollum, through its action on the inorganic phosphate concentration of the blood serum. Figures have been obtained for the so-called critical level of serum phosphate above which caries does not develop and below which caries is common. But these data cannot be applied directly to children without further study. The contribution of the Johns Hopkins University investigators offers interesting possibilities for future investigation.

EFFECT OF VITAMIN C

Bleeding gums and loosened teeth have been recognized as symptoms of scurvy for about 200 years. Although poor teeth have been produced experimentally in the guinea-pig by diets lacking in vitamin C, it was not until the work of Zilva and Wells and of Howe that this fact received considerable attention. Dalldorf and Zahl have studied the effect of vitamin C deficiency on the growth of the teeth of guinea-pigs. Howe found marked degeneration in the pulp, dentin and gums in scorbutic guinea-pigs and monkeys. The teeth became soft and decayed, and a condition very similar to pyorrhea alveolaris developed. All these changes could be prevented by feeding vitamin C.

Höjer has, indeed, utilized the changes occurring in the teeth of guinea-pigs as a means for the quantitative determination of vitamin C in foods. By ascertaining the least amount of material added to the scurvy-producing diet that would prevent the onset of gross lesions, Eddy found that small amounts of orange juice were sufficient to prevent readily observed scorbutic lesions in guinea-pigs, but twice as much was required for normal tooth formation. Similarly, 10 gm. of ripe banana was needed to produce good teeth, but only 5 gm. sufficed for general growth. These experiments are important and should be repeated in order to ascertain whether it is generally true that twice as much of the quantity of vitamin C that has been called adequate for the general metabolism is required for the protection of the teeth.

As a result of an investigation of the dietaries of a large number of persons, Hanke came to the conclusion that, in many, the vitamin C concentration was distinctly below what he considered to be the optimum. In cooperation with several Chicago dentists, a study of the effect of diet on dental caries was begun. The recommendations for the individual daily menu included the consumption of a pint to a quart of milk, some meat, fresh vegetables, one fourth to one half head of lettuce and the juice of one lemon added to sufficient orange juice to make a pint. For children, the recommended quantities were halved. Of eighty-nine cooperating patients, sixty that had previously been afflicted with an active, progressive decay did not develop new carious lesions, nor did the existing, unfilled lesions increase in size during an eight-month period of dietary control.

While Hanke himself has stated that the important factor is not some one constituent of the diet, but a liberal amount of all of the dietary essentials, there

is still the tacit assumption that vitamin C is directly responsible. For example, it was stated that several patients did not improve with one half pint of orange juice, but did respond favorably when the amount was doubled. In a pint of orange juice, there are several important food factors besides vitamin C, and control experiments with orange juice heated so as to destroy the antiscorbutic factor were not performed. Others have pointed out that Hanke's dietary recommendations, like those made by other investigators, improve the diet in a number of particulars. The question of the precise food elements essential for good teeth is an important practical problem. Certain fruits may be economically, geographically, seasonally or otherwise unavailable, and one should be able to supply a substitute. On the basis of Eddy's assay, the nearest equivalent of a pint of orange juice would be about 3 pounds of bananas. There is some evidence that many persons having sound teeth never consume nearly so much vitamin C as the massive dosage used by Hanke; and Hess and Abramson have pointed out the prevalence of dental disorders in tropical countries, where fresh fruits and vegetables, foods rich in vitamin C, make up a considerable portion of the dietary.

OTHER FACTORS

In addition to vitamins C and D, there is some experimental evidence that vitamins A and B may exert an effect on tooth formation and preservation. Bloch has found that children blinded by keratomalacia in infancy have teeth equal to those of children who had never been subjected to a gross vitamin A deficiency. In general, it seems that prolonged dietary deficiencies of almost any kind and of the severity possible in animal feeding experiments are accompanied by more or less defects of the teeth.

Under certain conditions, metallic poisons, such as lead, arsenic or certain radioactive elements, may accumulate in dentin or enamel. Experiments with young animals have shown that the ingestion of fluorin, a normal constituent of bones and teeth, in amounts that seem quite small, leads to marked alterations of these structures. Because fluorin occurs in foods and some potable waters—never in more than traces even in the richest sources—the possibility that this element might be consumed in amounts harmful to the developing teeth of children may not always be remote. This is illustrated by the recent elucidation of the cause of the curious anomaly known as mottling of the enamel. McKay had called attention to this condition in children living in certain well-defined regions in Arizona, New Mexico, Colorado, Texas, Arkansas and elsewhere. Kempf and McKay were able to prevent the defect in Bauxite, Ark., by changing the water supply from a deep well to a nearby river. The water from both sources was examined spectrographically by Churchill, who discovered the presence of fluorin in the well water. Water supplies from other sections where mottling of teeth is endemic also showed small amounts of fluorin. Interestingly enough, none was found in water east of the Appalachian Mountains, where the condition of mottling has not been reported. More recently, Smith, Lantz, and Smith, at the University of Arizona, succeeded in producing mottling of enamel in the teeth of rats and dogs by administration of fluorids in either the food or the drinking water. As a result, therefore, of the combined efforts of a dentist, a hygienist and public health official, a chemist,

and a group of biochemists, a notable success was achieved in unraveling what had hitherto been a very perplexing problem.

Jones and her collaborators have fed dogs on diets consisting chiefly of lean meat and white bread and observed a rampant disintegration of the crowns, a condition to which they gave the name of "odontoclasia." A similar condition has been noted in the deciduous teeth of a few children in California and in many children in Hawaii. In these cases, the diet appeared to be the principal agent leading to the defects, and the teeth could be improved by dietetic control. Jones and others believe that the acidity of the diet plays an important part in dental hygiene, but the evidence is inconclusive.

The belief that carbohydrates, particularly pure sugar, may cause tooth decay, has received considerable attention. The consensus of opinion seems to be that sugar in itself has no harmful effect, but that the consumption of this purified food substance which furnishes a large proportion of the calories required may lead to a relative deficient intake of other necessary substances that occur in natural foods.

CRITIQUE OF ANIMAL EXPERIMENTS

To obtain accurate experimental data, it is necessary to vary but one factor at a time, a condition that can be fulfilled only by animal feeding experiments; but, in order to translate such findings into terms of human nutrition, it is equally essential to remember that there are distinct differences among species. Thus, the quantitative requirements of a guinea-pig for vitamin C can be fairly accurately determined, but we have little information to guide us in the interpretation of such findings in terms of human subjects. The guinea-pig, the monkey and man are susceptible to scurvy, but typical lesions have never been produced in the dog, rabbit, prairie dog, pigeon or fowl. The mouse and rat thrive for months on the same diet that induces severe scurvy in the guinea-pig within three weeks. On the other hand, rickets has never been produced in the guinea-pig or kitten; whereas, the puppy, rat and baby are susceptible.

In addition to general differences in metabolism among various species, there are structural differences in the teeth. The incisors of rodents are rootless and grow continuously throughout life. Although the small molar teeth may be used in experimental work, some of these species are monophyodents. The teeth may be well developed before the animals can be placed on the experimental regimen, and the element of time becomes a matter of importance. Despite these obvious handicaps, and the difficulty of finding the most suitable experimental animals, it is not possible to make controlled experiments involving one factor only, unless animals are used. But the interpretation of such results must be tempered with the knowledge that the findings may not be applicable *in toto* to human subjects. An extensive clinical experience covering a considerable span of years will necessarily be the final criterion.

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BUREAU OF PUBLIC RELATIONS

LIFE INSURANCE AND THE MEDICAL EXAMINATION

By MILLARD D. GIBBS, D.D.S., Hot Springs, Ark.

THE subject "Life Insurance and the Medical Examination Required" may not mean a great deal to a group of dentists assembled for the purpose of dental study. Yet, when I have explained further, we will find, I am sure, that instead of being foreign to our interests, it is in reality a matter of great importance to every member of the dental profession, and to the medical profession as well, not so much from the standpoint of what *is* required, but of what *is not* required in the regular medical examination for life insurance.

Recently, in a paper read before the Arkansas State Dental Association and the Garland County-Hot Springs Medical Society on the subject "Why the Need of Cooperation Between Physician and Dentist?" I mentioned the medical examination for life insurance and how completely dentistry is ignored in that field. At this time, I wish to go into the subject of insurance examination more fully and try to show just how shortsighted it is to ignore the oral cavity in checking up on the physical condition of the average applicant for life insurance. Such insurance is a real benefaction to the human race, for we know that, in many instances, if it were not for such protection, many homes would be left in destitute circumstances with the passing of the breadwinner. We have seen how, through this means, men have been able to build an estate, which otherwise would have been impossible. In fact, there are many advantages of this form of insurance which I might mention, but time does not permit. This might be added, that through the growth and expansion of these corporations, a remarkably wide field of endeavor has been developed, giving employment to a vast army of workers, both men and women, of every tongue and nation. Accomplishments like these are to be commended.

Criticism of anything or anybody is not difficult if we are out for blood, but if we try to make our fault-finding of a constructive rather than a destructive nature, we have helped rather than hindered. With my attitude towards life insurance companies thus clearly stated, let me present what, in my opinion, should not only tend to make of these companies benefactors of humanity in monetary matters, but also make of them leaders in promoting better health among all nations.

In many instances, the applicant for life insurance faces a medical examination for the first time, and if, at this time, he were informed of the hazards that may be just around the corner, how much better might be his chances of escaping them. Looking into this question

of insurance as regards the medical examination required, we find that men have been known to apply for insurance although they feared they could not pass the physical test. After being examined and being told that they would be classed as a good risk, perhaps an A-1 risk, they have, as it were, taken a new lease on life. No doubt this applicant, let us grant, answered the questions asked him truthfully, but did they cover the ground upon which he had based his fear? Economic conditions change, and a few years later we find this man in great need of funds to meet some pressing demand. He recalls the fact that, by this time, his policy must have a nice loan value, and forthwith he takes the necessary steps to negotiate the loan. This lifts a great burden, and he settles back in his chair feeling younger and able to smile again. Months go by, maybe years, and this man begins to realize that the money borrowed on his policy depletes the estate he had planned to leave. Not being financially able to pay off the loan, he decides to take out additional insurance, but what of his physical condition at this time? His teeth, tonsils and perhaps other parts of his physical being were not included in the medical examination required by the insurance company when he was accepted by them a few years before. Pulpless teeth, apparently harmless, from which he had had no discomfort, may have been present, or perhaps tonsils that had given him no concern; but, on this occasion, when he needs additional insurance to bring his estate to its original value or to enlarge it because his heirs have increased in number, he is told that he did not pass the examination. The hidden sources of infection existing at the time that he was accepted have come to light, and perhaps the heart, kidneys, appendix, gallbladder or other organs are affected as a result.

This is not an exaggerated case, and during these few, but long years of depression that nations are passing through, hundreds of parallel cases could be found. The medical examination, as prescribed by insurance companies, does not go far enough, to say nothing of overlooking the oral cavity.

The terms "health" and "disease" are defined according to Gould's medical dictionary thus: *health,* that condition of the body in which all the functions are performed normally; *disease,* a disturbance of function or structure of any organ or part of the body. This authority also defines a tooth as one of the small bonelike organs occupying the alveolar processes of the upper and lower jaws.

If we accept these definitions, how can we, in sincerity, pronounce any pulpless tooth healthy or the individual who possesses them, in a healthy state? The nerve and blood supply having been destroyed, the normal resistance is certainly weakened, and any impoverished state of structure or organ makes of those parts avenues for the entrance, lodgment and growth of bacteria.

What does this insurance examination determine as to the condition of the blood stream? Applicants may have pathologic conditions such as syphilis, tuberculosis and many others lurking in the dark and answer "no" truthfully when they are asked if they have ever had any of them. We know that only blood tests and careful and minute examinations will reveal these conditions. Applicants of this type have been passed by examiners and later the conditions above mentioned have come to light. Naturally, the company desires to be informed as to how that applicant passed a favorable examination. This, in my

opinion, is the answer: because of the family history plus the inadequate medical examination required by the company.

Unfortunately, the fee allowed at present is not sufficient for a thorough examination, even from a medical standpoint, and certainly would not cover a dental examination. This is not the fault of the medical examiners: they are doing all that is required of them. By this laxity relative to a comprehensive physical survey, the insurance companies are, I believe, in an unintentional manner failing in their duty and forcing their examiners to misrepresent to applicants their true physical condition. In most instances, this type of examination suffices as far as the insurance company is concerned, for the records of mortality and longevity compiled by these companies are of such nature that acceptance or rejection is easily determined.

We are also aware of the fact that life insurance is sold on the group basis, under which plan a questionnaire is furnished the applicant, and he is either accepted or rejected according to his own answers. The American Dental Association has such insurance. Men in this group know they should have a physical examination at regular intervals, but let us not overlook the men and women in other walks of life who are not so fortunate as to have been trained in health problems as we have been.

Insurance companies are called benefactors of humanity, and rightly so, but how much more far-reaching they would be in that particular were they to go into health investigations thoroughly. Had the applicant for life insurance who was accepted been carefully examined dentally, he might have been warned of approaching danger by the dentist and conditions corrected; which would have made him a far better risk.

I have been informed that the rejections for insurance now amount to about 20 per cent.

From wide experience, the two professions recognize the large part that oral infection plays in systemic conditions. Then, is it unreasonable to suppose that, if these rejected applicants had been carefully examined from a dental viewpoint, and oral sepsis eliminated, a substantial percentage would have, in from six to twelve months, been made acceptable to the company who rejected them? If we would promote good health and long life, it behooves us to be ever watchful lest we overlook the hidden sources of danger which would make insurance impossible, to say nothing of failing to safeguard the health of those who look to us for guidance.

Recently, I was examined for additional insurance and passed an excellent examination, but my teeth were not considered in arriving at the conclusion that I would be a good risk.

It has been my good fortune of late to discuss insurance with several agents, and I have done so very frankly, with the questions I am presenting to you, and these agents have been just as frank and some have told me that they favor the examiner who is most lax in his examination. One of the agents in whose company I was examined told me that they had two or three examiners and that I could have my choice. When I made my selection, the agent remarked that if it made no difference to me, he preferred another man as he was more experienced in this work and was not so strict, and he could "handle" him better. We can readily see why this is of advantage as far as that particular commission to the agent is concerned, but what of

the day when the company begins to check up on individual agents and the losses to the company from his clients? The examiner can also be checked up on his recommendations. I do not believe the medical profession endorses this sort of thing, neither would they individually or collectively be proud of such a reputation as an examiner for insurance companies, or in private practice. I have discussed these matters with men of the medical profession, as well as insurance representatives, and, if you have any doubt as to the accuracy of these statements, investigation will verify all that I have said.

According to information at hand, I am sure that the insurance companies, from an economic point of view, do not deem it expedient to incur the additional expense such a physical examination as I have tried to outline would entail. Yet they spend money for advertising in the form of the attractive folders that they enclose with the notices mailed out for premiums due. The medical advisers of these companies could write articles calling attention to health and how dental disorders impair one's health, and of the importance of regular medical and dental examinations. Such educational advice could be mailed with the regular notices above mentioned. Why not let the applicant for insurance know, by a simple statement in the questionnaire that the examiner uses, that the examination which they have just taken does not cover their physical condition in anything like a complete manner and that they should, at regular intervals, go to the physician and dentist of their choice for complete examinations? Better still, why not incorporate in the present lists of questions to the applicant the following:

Do you pay regular visits to a dentist?

When did you last have a dental examination?

Have you ever had an x-ray examination made of your teeth?

Have you any pulpless teeth?

What is the condition of your gums?

If these matters were brought to the attention of the insurance companies, I believe they would be received in a friendly and cooperative spirit, for these organizations are progressive and would appreciate rather than ignore any suggestion of a forward step emanating from the medical or dental profession relative to health problems. These two groups are fully alert as to the importance of these questions, but those of whose health we are supposed to be custodians are not always informed as they should be, and when they do have an opportunity for gaining knowledge regarding their health, it most certainly should not be denied them. In asking the insurance companies to stress these important health factors, we are doing one of the big things our professional training taught us: serving suffering humanity. The course of study that we pursued was not followed without cost, hard work, time and sacrifice. Therefore, with our training and experience, we have the right to ask that more consideration be given these very much neglected problems. Looking backward, we can recall many crude methods practiced by the medical and dental professions and can but marvel at some of the methods used. Progress for many decades has been made by these two groups and, as time goes on, we will see much more advancement, for men in both fields of labor are daily engaged in research work.

Insurance in every department has made its progress and will continue to

do so, and it is with this thought in mind that life insurance companies, progressive as they are, will not fail us in this, a forward movement in the great question of health.

Summing up the outcome of such examinations as I have tried to outline, there should result: better risks, fewer permanent rejections, greater value of insurance as a guide in health problems, less likelihood of the holder of the policy's being rejected later for increased insurance, and less possibility of partial or total disability from these otherwise hidden sources of infection.

Let us discard the bad of the old and grasp the good of the new by rendering the best services possible to a humanity clamoring to keep physically fit, and, as this march of progress continues and we shall see our efforts mount to higher peaks, among the notable achievements will be the recognition by all of the leading life insurance companies of the importance of a more complete medical and an added dental examination.

DENTAL ASSISTING IN AN OFFICE OF A DENTAL PEDIATRICIAN*

By IRMA HESCH

IN this age of specialization, it is the pediatrician who cares for the children. Under his skilful care, they develop healthier bodies, keener minds and stronger constitutions.

We also have the dental pediatrician, under whose guidance children are cared for dentally. If, at the age of 2 years, a child is placed in the care of a dental pediatrician, making regular visits every three months, having been trained and educated to know the value of dental health, there will be a greater assurance of healthier mouths, stronger teeth and fewer dental defects; which are important factors in building and retaining good health.

To better understand the value of this care, and the conscientious and thoughtful manner of handling every type of child patient, let us mentally look in on a dental pediatrician (whom for convenience, we will call Dr. Bell) during one of his busiest days.

We find Miss Carr, Dr. Bell's assistant, seated at her desk looking over the appointments for the day. In making appointments, she always learns the child's first name and age, and inquires as to whether the child has visited any other dentist and, if so, what work was done. This information is valuable, as it enables Miss Carr and Dr. Bell to call the patient by the first name, and, from past experience, they can judge the type and act accordingly.

Jane Smith, aged 3 years, is the first patient. This is her first visit to a dentist, and her appointment is for 9:30, the hour being much considered, for at this time, having just awakened, she is

*Read at the Seventh Annual Meeting of the American Dental Assistants Association, Memphis, Tenn., October, 1931.

thoroughly relaxed and will cooperate to a greater extent than if she had played a few hours before her appointment and become fatigued.

The door bell is ringing, and Miss Carr is admitting her. "Good morning, Jane." Little Jane's face is all aglow and it seems to say, "Why, she must know me, because she called me by my first name."

"May I help you remove your wraps?" Meanwhile Jane is glancing from chair to chair, deciding in her mind which one she will sit in.

"Sit down, Jane, and here is a book for you to look at. Isn't this a pretty dog? Do you have one? What is his name? Pal! Why, I think that is a fine name for a dog. Oh, you have a dolly too, two of them! No, I don't have any." And the conversation is carried on until Miss Carr feels she has made a friend of Jane.

Dr. Bell is ready for Jane, and Miss Carr is inviting her into the operating room. "Come in, Jane, please!" Jane's eyes are as big as dollars as she views the wall decorations, which have been placed to attract attention.

"This is our elevator—see how is goes up and down?" Jane is looking it over, and at the invitation of Miss Carr she is "taking a ride."

Your dress is very pretty, Jane. I will place a napkin over it so as not to spill any water on it when Dr. Bell rinses your mouth." Jane is watching every move Miss Carr makes.

"This little bulb is like an electric fan —see, doesn't it feel cool on your arm? And this is a mirror—can you see how large it makes your finger nail appear? Your mouth is so tiny that Dr. Bell will use it to see how very pretty your teeth are."

"And this little thing is our 'tooth-pick.' Sometimes, food lodges between your teeth, and Dr. Bell picks it out with this and at times it will sound as if Dr. Bell is playing a tune on your teeth with the mirror and toothpick."

No other instruments have been placed on the table, and Jane, knowing what each one is for, has no fear, and Dr. Bell proceeds with the examination. Examination reveals the need of a prophylactic treatment. Dr. Bell has told Jane just how he will clean her teeth and she is very eager to taste the "chewing gum tooth paste." The treatment is over, and Jane's nurse has been taught the correct method of tooth brushing, after which, with her nurse's permission, Jane is given a chocolate "bud" as her reward for good behavior.

The next appointment is for Johnny Jones, aged 6. At the time his appointment was made, Miss Carr was informed by his mother that he had had an aching tooth for several weeks, and within that time had visited two dentists, only to scream and cry; eventually being taken home without any relief accomplished. "But then she did not blame him much, as she has "always been scared green of a dentist," and without a doubt it is "born in him to be afraid."

Johnny's visit will require much patience on Miss Carr's and Dr. Bell's part, as, from his mother's conversation, they know she has instilled this fear he experiences and it is predominant in his mind.

Johnny is here, and Miss Carr's friendly manner has helped lessen the tenseness that was gripping him in wondering just what "this visit" would be. Miss Carr has asked Mrs. Jones to remain in the reception room, and Johnny is in the chair.

"Will you have to pull my tooth, Nurse?" "I do not know, Johnny, but

you forget about your teeth, as first Dr. Bell will examine them, and will tell you what is necessary before doing it, as neither he nor I ever tell untruths to little boys."

Examination reveals abscessed teeth, and immediate extraction is the only choice in this case.

"Johnny, you have two teeth which have been giving you the toothache all this time, and Dr. Bell wants to help you, so he is going to take them out." "Will it hurt me, Nurse?" "No, if we wanted it to hurt, we would not do it this way. We are going to put you to sleep to take them out, and I will show you exactly how it will be done. First, Dr. Bell will put this piece of rubber between your teeth to bite on, and it will keep your mouth open while you sleep. Then I will place this little rubber thing over your nose, and we want you to try to sneeze it off. Then you will smell something sweet and, after a few breaths, you will see our heads twirl, and the next thing you know, you will be awake and your teeth will be out. Now isn't that an easy way, and if you breathe just like this, and make this little thing click, it will be very easy to do, and there is no need to be afraid. The braver boy you are, the sooner you may go home."

Johnny is awake; he has not known anything about the extraction, and his confidence is well established in Dr. Bell and Miss Carr, as he knows that when he is told anything by them, it will be the truth.

The next appointment is for Jimmy Black, aged 8. He governs the home, and intimidates his playmates. He has visited seven dentists and no one could manage him.

He is in the reception room, and Miss Carr's invitation to him to go into the operating room is met with rebellion. "I am not going in there." "Jimmy, we do not permit boys to act this way in our office. Your mother brought you here to have your teeth examined, and you are not going to leave without that being done. While you are here we are 'boss,' and I want you to come in and sit in the chair."

He is in the chair and Dr. Bell is approaching examination. "Open your mouth, please." "No, I won't." "Jimmy, I said 'open your mouth.'" Jimmy halfway decides to open it, but, on second thought—why should he sit in a dentist's chair, if *he* does not want to? No sir, he just won't open his mouth, and soon they will get tired of it too, and submit to him as his mother always does. "Are you going to open your mouth of your own accord, or shall I speak to your mother, and with her consent it will not be so nice?"

Jimmy remains stubborn, and, with his mother's approval, the Forsythe method of discipline is used, by holding his body in firm position, and placing a towel over his nose and mouth. After a few minutes' discomfort, Jimmy realizes that he "has lost out here," and submits to treatment.

Betty Lou Brown, aged 4, is the next patient for today. She has been in for examination, and today Dr. Bell will start filling her cavities.

She is in the chair, and excavators have been used as much as possible. "Betty Lou, this is our 'bee' in your mouth that makes a buzzing noise. See how it files your fingernail. That is the way it takes all the decay out of your tooth, so that a pretty shining filling may be put in its place. Sometimes it may sting a little bit, but just sit tight and it will soon be over; but if it hurts too much, raise your foot and I will stop for

a minute. Did you ever hear the story of the boy who called wolf so many times that when one came no one believed him?" While preparing the cavity, the story is told and the logic is perfect.

"We are almost finished, Betty Lou. Now your tooth is ready to have the shiny filling placed in it. Let me put these pieces of cotton on each side of your tooth. They will keep it dry, while your filling is getting hard. You have been a good girl, and while we are waiting for the filling to set, I will read a story to you. You hold this book and turn the page when I tell you to."

Betty Lou has been in the chair thirty minutes. This is the approximate amount of time for each patient, as it is best to have several extra appointments than to keep her for someone's convenience, regardless of her fatigue.

Each day presents new patients, new types to "diagnose," in order to render successful service.

Obviously, preventive dentistry has its origin in dental pediatrics, and any dentist will gladly welcome a patient who has been under the supervision of a dental pediatrician who has made that patient the cooperative patient of tomorrow.

MEMBERS OF THE DENTAL PROFESSION INVITED TO ATTEND A.P.H.A. MEETING

Progressive dentists everywhere realize that an important part of a modern health program is the understanding and use of the dental facilities of the community. The prominent part played by the private dentist in the education of his patients and the preservation of their health is generally acknowledged.

At the Sixty-First Annual Meeting of the American Public Health Association in Washington, D. C., October 24-27, the dental profession will find much of interest and value in the scientific discussions, the exhibits and the contact with fellow health workers.

Of paramount importance to those members of the dental profession who are alive to the preventive aspects of their work is the round table discussion on school dental problems presided over by the Supervisor of the Bureau of Public Relations of the American Dental Association.

Remember the dates and arrange to attend. Reduced railroad fares are available to all members of the American Public Health Association. The Willard Hotel will be headquarters.

CURRENT LITERATURE

EXTRACTS AND ABSTRACTS

Dental Phases of General Anesthesia: Anesthesia for oral and dental surgery differs from that demanded in general surgery in that the medium selected must be suitable for use in a dental office; the gases must be under sufficient pressure to prevent their dilution by air inspired through the mouth; there is need for maintaining an adequate carbon dioxid tension in the alveoli of the lungs, and also for using mouth packs. (Harry B. Seldin, in *Cur. Res. Anes. & Anal.*, May-June, 1932.) Nitrous oxid and ethylene can be used for prolonged anesthesia in oral surgery. The latter is more potent and does

not require such a highly developed machine for its administration. It causes fewer post-anesthesia complications and assures greater relaxation than certain other anesthetics, but as it produces much more nausea than does nitrous oxid, its use is disadvantageous in the dental office, where, in addition, the lingering nauseating odor is not conducive to the comfort of subsequent patients. The great explosive hazard associated with the employment of ethylene, as evidenced by the long list of recommendations and precautions issued by the manufacturers of medical gases, places it outside the pale as far as office oral surgery is concerned, since it is physically impossible for any dental office to institute all the precautions listed, none of which can be with safety disregarded. From the patient's point of view, nitrous oxid-oxygen is the best and safest general anesthetic that the dentist has at his disposal. In a questionnaire mailed to the leading exodontists of the country, eighty-nine out of 130 preferred nitrous oxid in the case of the handicapped patient and only three preferred ethylene-oxygen. The author feels that many dental anesthetists put too much stress on cyanosis, and that while no one will doubt the efficiency of this condition as a guiding sign in the normal individual, the anesthetist will meet with disappointment if he attempts to apply it as a symptom in the anemic and plethoric. With ethylene-oxygen, the patient will not present cyanosis so readily as with nitrous oxid, but this does not indicate that there is less anoxemia present. The main technical difficulty encountered in the administration of the nitrous oxid-oxygen for oral and throat surgery is the prevention of dilution of the anesthetic with air inspired through the open mouth. This can be overcome by delivering the gases under sufficient pressure, and, in oral surgery, also by the proper packing of the mouth with a suitable gauze pack, which will also prevent the accidental passage of a tooth filling or other material into the esophagus and trachea, and, to a great extent, the seepage of blood into the stomach. The maintenance of an adequate supply of carbon dioxid in the body during gas-oxygen anesthesia is of great importance. During anesthesia without hypnotics, there is a tendency to overventilation due to increased rate of respiration, to overcome which carbon dioxid may be added to the inspired gas. It must be used with discretion. If carbon dioxid is employed to obtain a spontaneous increase of respiration, larger percentages may for a short time be employed, but if it is administered continuously throughout the anesthesia, it should under no condition ever exceed 5 per cent, the average amount being 0.5 to 2 per cent. Excessive stimulation of the respiratory center will in time cause its fatigue and ultimately its failure. In the hands of the average dentist, rebreathing, though somewhat slower, is undoubtedly the safer means of maintaining the normal alveolar carbon dioxid concentration.

Treatment of Cancer of the Lip by Electrocoagulation and Irradiation: This paper, by G. E. Pfahler and J. H. Vastine (*J. A. M. A.*, Jan. 2, 1932) is based on a review of 253 cases taken from the private practice of the former and covering a period from 1902 to the end of 1930. Of these cases, 88 per cent were in men. The youngest patient was 23, the oldest 85, with 74 per cent of cases occurring between the ages of 40 and 70. The great majority of patients gave a history of smoking to excess, including all cases in men. In two cases, there had been a burn by a cinder; in three, the lesion followed sunburn; in two, the patient bit the lip; in nine, lesions followed repeated razor cuts, and in one, a burn with lime; in two cases, rough teeth were a factor; in four, the epithelioma followed bruises; in three, the lesion began as a fissure and in eighteen, as a "fever blister." A biopsy is made routinely and the case is treated as malignant while the report is awaited. A former objection to biopsy as dangerous is obviated by this procedure. The high percentage of cures, 95.5 per cent, in all primary cases treated, not including recurrent cases, justifies this measure. The percentage of recoveries in recurrent cases has been 71. In early cases, a fine needle with the high frequency current is used and the lesion is surrounded with a line of local destruction. After the specimen is taken, the local lesion is destroyed completely. If the disease extends deep enough to reach an artery in an elderly patient with arteriosclerosis, a suture ligature is used instead of simple sealing of the area with the high frequency current, to avoid secondary hemorrhage. When lesions are relatively small, this destruction and sub-

sequent roentgen treatment leave a soft scar and practically no deformity. Local destruction in the early cases without palpable lymph nodes and followed by high voltage roentgen treatment of the lymphatics has given 99 per cent recoveries. Of all types of cases (179) that were treated more than five years ago, 85.5 per cent have been cured, including the recurrent and metastatic cases. In dealing with primary cases associated with palpable lymph nodes, the authors usually add radium packs over the lymphatics and at times insert radium needles into the lymph nodes and around the lymphatics likely to be involved.

Dental Technic in Relation to Oral Sepsis: Prosthetic Dentistry: Without going deeply into the details of present day methods of artificial restoration by prosthetic means, I will, if I may, take a bird's eye view of how modern dental methods stand in this sphere. We have improved in many ways: in the accuracy of our restorations, in our ability maybe to deceive a careless public eye: but I feel that any glorification of our successes on this side only emphasizes our lack of success in our fight with dental disease. And what a vicious circle it is! The more expert we become in disguising the ravages of dental diseases, the less value is set upon the conservation of the natural organs of mastication and healthy teeth in a healthy mouth. The bulk of dental practices of today are undoubtedly supported in the main by the artificial work necessary and gladly paid for on the principle of any port in a storm. The conviction of the guilt of oral sepsis has driven us further on the road to early destruction of the natural teeth; we cannot and do not gainsay the sane medical view that an empty mouth is preferable to a septic one, especially in these days of palatable and easily assimilated nourishing foods which need no masticating effort. Our only hope of stemming the tide is by far-reaching education in the matters of preventive and oral hygiene, and in our efforts in this direction we need every ounce of support that the medical profession can give us. We *know* how inadequate a restored mouth is when compared with a natural normal standard; the danger I visualize is that our medical brothers do not recognize this and in their flattering confidence in our superlative ability to rectify matters, allow themselves to drift into an unworthy acquiescence in what is really a desperately poor standard of physical well-being. How does prosthetic work of today stand in relation to oral sepsis? We have advanced in the quality of our materials, not very much; in fact, artificial teeth may be produced in bigger variety, but certainly not better quality than twenty-five years ago; mass production has as usual broadened output, but levelled down quality. And the mass production has followed the perception of the perils of oral sepsis. Throughout the health insurance system runs the bias in favour of complete clearances as against partial dentures. As a regional dental officer, I am bound to say that in the main the bias is justified by the extraordinarily hopeless condition of most of the cases. Our only hope of turning the balance in the direction of conservation treatment lies in the spread of education in hygiene and dental prophylaxis. One hopes and believes that school dentistry is a growing power in this respect; yet last week I met a case of utter neglect and downfall of a mouth in a patient between twenty and twenty-five. His dentist ascribed the deplorable condition directly to school dentistry; as a boy the patient had one tooth filled (it was still present and good), since when he had studiously avoided the dental surgery. Maybe an isolated case, but it serves to show how human and sympathetic it is necessary for school dentists to be if their efforts are to be both successful and appreciated, and not hasten the young patient on a downward path to self-destruction.—Arthur H. Parrott, in *Birmingham M. Rev.*, March, 1932.

Relation of the Fluorin Content of Drinking Water to Occurrence of Mottled Enamel: Practical methods of removing fluorin from public water supplies are being investigated in the laboratory of the University of Arizona, according to Smith, Lantz and Smith (*Arizona Pub. Health News,* June, 1932). In a study of the cause of mottling of enamel, detailed family histories of the inhabitants of St. David, Ariz., where the condition was endemic, were taken, and it was found that all persons born and raised in the community suffered from the condition of mottling. Dietary deficiencies such as might account for defects in the enamel were not

found. Conditions similar to mottling were produced in experimental animals given the residue from evaporated water from the St. David community. The addition of sodium fluorid to the diet had the same effect. An analysis of the water from St. David and other communities to which the condition was endemic revealed the presence of abnormal amounts of fluorin. Investigations now going on correlate the concentration of fluorids in the water with the degree of mottling found in various communities. The investigation is state-wide, approximately 110 public and fifty-five private water supplies having been analyzed. At least forty-five communities in which the condition is endemic have been found, the mottling varying from very mild to severe. The majority of these communities lie along two rivers. The degree of mottling varies with the amount of fluorin found in the water of that community.

Roentgen Treatment of Agranulocytosis: Gager and Speer (*Am. J. Roentgenol. & Rad. Therapy,* January, 1932; abstr. *J. A. M. A.*) report two cases of agranulocytosis, with recovery. Roentgen irradiation was the only general therapeutic agent employed in the crises of the disease. While the clinical facts and the already rich literature make comment at any length unnecessary, there is offered to the authors' minds, unequivocal demonstration of the specific value of roentgen radiation in stimulating the production of granulocytes and of the body as a whole. This surprising result of a minimal roentgen dosage in such a serious disease picture offers for analysis a roentgen-ray effect of great biologic interest and, not less important, the nature of the pathologic process which thus reverts to normal.

Contract Practice: Although there are many details of contract practice which deserve much more detailed description and comment than is possible in this report, it may be stated that contract practice (1) took its origin largely from necessity; (2) has been legalized, in certain places, by state statute; (3) under certain conditions and in some forms is both ethical and legitimate; (4) in general, has become highly commercialized and competitive; (5) is largely limited to the pay roll class; (6) does not, in most cases, extend its provisions to women and children; (7) concerns itself, almost without exception, to curative medicine and does not include preventive measures; (8) shows no interest in public or individual welfare; (9) furnishes medical care which is often inferior in character; (10) in many instances is characterized by underbidding, subletting, misrepresentation and racketeering; (11) is economically unsound in many of its present forms; (12) is essentially sickness insurance usually not supervised or regulated; (13) is often used by the operators thereof to influence legislation in favor of extension of the plan; (14) in many of its present forms, lowers the confidence of both the individual and the public in the medical profession; (15) has some features that deserve refinement and extension and others that are unethical and dangerous and should be abolished.—R. G. Leland, in *J. A. M. A.*, March 5, 1932.

Bacterial Content and Disinfection of Toothbrushes: Viefhaus (*Arch. F. Hyg. u. Bakteriol.*, January, 1932; abstr. *J. A. M. A.*) found that newly purchased toothbrushes, whether they have a protective covering or not, are not sterile, for he detected many bacteria, some of them pathogenic. Because of this he considers the sterilization of newly purchased brushes absolutely necessary. Most of the methods that have been recommended for the disinfection of toothbrushes he found to be ineffective, such as sodium chlorid even when used in a concentrated form, also formaldehyd vapors that develop at room temperature. However, formaldehyd vapors that are developed under the influence of heat, when potassium permanganate acts on a formaldehyd solution, effect complete sterilization in a comparatively short time. This reliable although somewhat complicated method is not suited for daily use but should be resorted to whenever it is necessary to sterilize toothbrushes of patients with such conditions as alveolar pyorrhea or with parodontitis. It is also suitable for hospitals and sickrooms, and it has the advantage that it does not in the least injure the toothbrush.

MISCELLANY

BOOK REVIEWS

The Real Meaning of Social Insurance—Its Present Status and Tendencies. By Hugh H. Wolfenden. Fellow of the Institute of Actuaries, Great Britain; Fellow of the Actuarial Society of America; Fellow of the Royal Statistical Society. 227 pages. Price, $2. Published by the Macmillan Company of Canada, Limited, at St. Martin's House, Toronto.

This book, written by an actuary of distinction, aims merely to present facts as he finds them, which is really the prime function of an actuary.

A note in the preface emphasizes this perfectly. The author says:

"Such observations of a sociological or political character which thus of necessity have been included have consequently neither been written, nor are they intended to be read, in any partisan political sense. This cannot be emphasized too strongly. The reader accordingly is asked to bear constantly in mind that this book is intended to record simply the basic and essential facts which constitute the fabric of governmental social insurance plans as they are known today, with a dispassionate analysis of the motives and arguments which constitute their defenses and their weaknesses. The author has therefore deliberately excluded all the emotional persuasion and impassioned rhetoric with which the subject so frequently is advocated and at other times assailed."

For a book of its size, this is a most comprehensive treatment of a subject that is today claiming the attention of thinkers in various avenues of activity, not only industrialists, sociologists and statesmen, but professional men and women as well. In the modern complex state of society, it behooves every thinking individual to study carefully these problems, and this book will go far toward aiding in their elucidation.

Your Teeth—Their Care and Preservation. By Lewis H. Urling, D.D.S. 67 pages. Price, $1.50. Published by Dorrance & Company, Inc., Philadelphia.

This is another of those small volumes that are appearing from time to time with the laudable effort of bringing information to the laity on matters concerning the dental health of the people. As the author intimates, most of the material has been gleaned from other sources, the aim being to formulate and apply the various theories and make them as simple and readable as possible.

Much emphasis has been given to the subjects of diet and the vitamins, and their effect on the teeth and on health generally. The more information of a practical character that we can furnish the people, the better, and the modest price of this volume will appeal to many readers.

Recent Advances in Anesthesia and Analgesia. By C. Langton Hewer, M.B., B.S. (Lond.). Anesthetist and Demonstrator of Anesthetics, St. Bartholomew's Hospital. Anesthetist, Brompton Hospital for Diseases of the Chest; Hospital for Tropical Diseases, London; Seamen's Hospital, Royal Albert Dock; Mount Vernon Hospital, Northwood; Queen Mary's Hospital, Roehampton, Ministry of Pensions; St. Andrew's Hospital, Dollis Hill. Late Senior Anesthetist, Queen's Hospital for Children. Late Anesthetic Specialist, Napsbury War Hospital; Woking Military Hospital. 64 Illustrations. 187 pages. Price, $3.50. Published by P. Blakiston's Son & Co., Inc., Philadelphia.

This book emphasizes the necessity of specializing in the administration of anesthetics for operating on different diseases, which is an idea seldom or never brought out. Thus, we see considered in the text the effect of anesthetics on the various organs of the body, on the nervous system, etc.

The subject of premedication is taken up briefly but effectively, with the indications and contraindications of the various drugs. While this book is essentially intended for the medical man, the fact must be realized

that dentists, particularly those engaged in the practice of exodontia and oral surgery, use anesthesia more frequently than do physicians, and there would accordingly have been a definite advantage if the author had referred more pointedly to anesthesia for the dentist.

An error in nomenclature is noted on page 95, where borocaine is stated to be beta eucaine borate. Borocaine is the proprietary name for procain borate.

The book should be read by every person interested in the subject of anesthesia, whether physician or dentist.

SOCIAL INSURANCE IMPOSSIBLE TO ABOLISH WHEN ONCE ESTABLISHED

By Edward H. Ochsner, M.D., Chicago, Ill.

The worst feature of social insurance is the fact that when this parasite once gets its suckers well fastened into the vitals of a nation, nothing short of national bankruptcy, a dictatorship or a revolution is able to loosen its hold.

Germany, which has had social insurance on its statute books the longest period of time, has, for a considerable time, been on the verge of bankruptcy. While other facts are operative, we believe that the billion dollars which social insurance costs the nation every year is one of the chief reasons that Germany is unable to make a satisfactory "come-back" to normalcy.

England is not much better off. The chief reason for England's present difficulties is the terrific burden of taxation which she has to carry. One writer says: "A complete understanding of the problems confronting England at the present time involves going back to 1909 when we had just adopted old age pensions and destroyed the foundations of thrift." In 1911, England introduced national insurance when 3 per cent of its workers were unemployed. After twenty years of operation of the act, 17 per cent of her workers are out of work. As a partial explanation for this condition, let us cite just one example from among scores and hundreds that could be given. A manufacturer found that his orders were only sufficient to give work to all his employes four days a week, so he called his workers together and told them the facts. The workers insisted that they would work only three days a week in order that they could draw the dole for the other three days. An English writer, commenting on this, says: "It is a great mistake to worry about the much discussed abuses of the system. It is the system which is fundamentally wrong and abuse is inseparable from it."

To get an idea of the tax burden which England is carrying, we need but cite facts. In that country, all incomes of $750 per annum are taxed 25 per cent. Higher incomes carry an additional surtax. Increased taxes have raised the production cost of practically all articles of manufacture and, as a consequence, have actually increased unemployment, because English industry, carrying this extra burden, has not been able to compete with other countries in the world markets. In spite of these burdensome taxes and in spite of the fact that living expenses had gone down 11.5 per cent, the recent labor government refused to cut the sick benefits 10 per cent, and put the nation to the expense and turmoil of a national election practically on this issue alone.

The countries just cited are not the only ones encountering similar difficulties. A recent newspaper article contained the statement that there are more than 150 federal boards and commissions in Washington, each with three or more members drawing salaries and each with a bevy of clerks, most of them just drawing salaries. Many of these boards and commissions were created during the World War. When a few far-sighted persons remonstrated against the appointment of so many boards and commissions, they were assured that they would all be abolished at the end of hostilities. It is now more than fourteen years since the signing of the Armistice but not one board has as yet been abolished.

Another illustration is the franking privilege to country newspapers. This privilege was extended to them when it was deemed desirable to disseminate news and information to rural inhabitants, particularly to detached settlements. It was a wise and legitimate enactment at the time, but now it is just a plain nuisance and yet no congressman would dare to suggest its abolition. It is costing the taxpayer and consumer a great deal of money and serves no useful purpose. A town of 10,000 or even fewer inhabitants usually has two and sometimes three local papers, all enjoying this privilege. The local merchants are compelled to advertise in all of them, the expense of which must of

necessity be passed on to the consumers. Incidentally, this favors the mail order houses to the detriment of the local merchant.

There are many reasons that it is almost impossible to repeal the laws governing such practices. One reason is that executives and legislators do not want them repealed because it reduces the power which they derive through political patronage. The more patronage the individual in office has at his disposal, the more difficult it is to dislodge him. Even today, it is very difficult to defeat a public office holder with a large political patronage, no matter how inefficient he may be, except by another who either already has a large political patronage, or who promises jobs to his supporters irrespective of their qualifications. Thus, in many elections, the voter is simply left to choose between two undesirable candidates. Already the payrollers have become so numerous and so politically active and influential that they yield great power in both political parties. If we then adopt compulsory health insurance, we will add further thousands to the lists of our civil employes. Those who are not in government employ will be powerless to control government and their only function will be to pay the taxes which others impose on them. Instead of increasing the number of government officials and employes, the ideal to be constantly kept in mind and striven for in this country is to permit the private citizen to perform all those functions that he can best perform and that make for independence, self-reliance and strength of character and to have the government do only those things which the individual cannot do satisfactorily. We maintain that centralization in government and paternalism have already gone much too far and that social insurance would simply be another step in the wrong direction.

Another reason that it will be difficult to repeal such laws is the fact that men in the different services of the government do not dare to expose its faults for fear of being accused of disloyalty. Reports must be couched in the most mild and ineffective language possible, and they must not be released to the public but allowed to die in still birth in the departments. We all know what happened to General Mitchell when he dared to disregard these rules. Maj.-Gen. Robert Alexander also tells, in the introduction to his "Memoirs of the World War" just how this attitude worked out in at least one other instance.

In most countries which have social insurance, such laws were first suggested and urged by welfare workers, uplifters and visionaries, who unwittingly played into the hands of practical politicians. Even now, few seem to realize that bureaucracy in a republic may become just as unreasonable, oppressive and ruthless as a despotism.

It will be interesting to see whether we shall be able to profit by the experience of others or whether, as a nation, we belong to that class of human beings who can learn only by dire personal experience or from national disaster.

(The next article will offer a number of countersuggestions in place of social insurance.)

ORGANIZATION OF AN INTERNATIONAL ASSOCIATION FOR THE STUDY OF PARADENTOSIS

On May 30, 1932, the "ARPA International" was definitely organized at Frankfort-on-the-Main. At the first meeting, three countries were represented: Germany, by Weski (Berlin) and Loos (Frankfort); France, by Hulin (Paris), and Switzerland, by Jaccard and Held (Geneva).

The "ARPA International" is an organization destined through the intermediary of its secretary's office to facilitate the exchange of ideas on the subject of paradentosis. This disease is considered to be of the same degree of importance as dental caries. A more intimate cooperation between internal medicine and odontology is to be encouraged; and the study of paradentosis from the standpoint of its recognition by social agencies (in those countries which are interested in this phase of the question) is to be undertaken.

The "ARPA International" will be under the auspices of the F.D.I. (under reserve of ratification by the Executive Council of the F.D.I.) and will meet each year, if possible at the same time as the F.D.I.

The general secretaryship, represented by Drs. Jaccard and Held, has its headquarters at Geneva. It has charge of collecting all articles relating to paradentosis and of indexing them.

The meetings will be presided over in ro-

tation by each of the countries represented. Each annual session will name its president.

Each national ARPA will have its own organization, conforming to the conditions of the country it represents.

The following national ARPA committees have been formed: France: Roy, Hulin, Georges Villain, Delater and Housset; Switzerland: Jaccard, Jung, Held, Haumann and Keller; Germany: Linnert, Siegmund, Boenheim, Citron, Loos, Weski; Italy: Palazzi.

At the first meeting in Frankfort-on-the-Main, it was decided to modify as follows the classification of paradentosis as it had been proposed by the Fourth Section of the VIII International Dental Congress: I. Gingivitis marginalis. II. Paradentosis: 1. Inflammatoria. 2. Mixta vel combinata. 3. Atrophica. III. Atrophia senilis physiologica.

Following the motion made by the Swiss ARPA, in order to promote a better understanding in the different languages, it was decided to use Latin terms.

The first annual assembly of the International ARPA was held August 7, at 10 o'clock, at the University of Zurich. This meeting followed immediately after the twenty-seventh session of the F.D.I.

Two papers were presented, one by Weski, of Berlin, the other by Hulin, of Paris.

Confrères have been invited to form local national committees in the following countries: England, Austria, Argentina, Belgium, Denmark, United States of America, Holland, Finland, Hungary, Italy, Norway, Russia, Sweden and Czechoslovakia.

Steps have already been taken to form a committee in the United States. Those interested should communicate without delay with Dr. Hermann Becks, George Williams Hooper Foundation for Medical Research, 2nd and Parnassus Avenues, San Francisco, Calif.

NEWS

DEATHS

Ellerbeck, W. L., Salt Lake City, Utah; Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania, 1887; died, August 12.

Hickman, Herbert Eugene, Chicago, Ill.; Northwestern University Dental School, 1901; died, September 11.

Smith, Murdock C., Lynn, Mass.; Howard University, College of Dentistry, 1887; died, August 28; aged 76. Dr. Smith held the degrees of M.D. and D.M.D. from Harvard University. He practiced dentistry for more than forty years and was prominently identified with organization and research work in his profession, especially research in endocrinology. Dr. Smith travelled extensively not only on the North American continent, but also in Europe and Africa.

ANNOUNCEMENTS*

CALENDAR OF MEETINGS

American Dental Association in conjunction with the Chicago Centennial Dental Congress, Chicago, Ill., Aug. 7-12, 1933.

American Society for the Advancement of General Anesthesia in Dentistry, New York City, October 24.

American Society of Orthodontists, Oklahoma City, Okla., April 19-21.

Eastern Association of Graduates of Angle School of Orthodontia, New York City, November 14.

Congress of International Anesthesia Research Society, New York City, October 17-21.

Greater New York December Meeting, New York City, December 5-9.

Montreal Dental Club, October 13-15.

Northern Illinois Dental Society, Rockford, October 12-13.

Odontological Society of Western Pennsylvania, Pittsburgh, November 8-10.

Society for Advancement of General Anesthesia in Dentistry, New York City, third Monday in February, April, October and December.

*Announcements must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

Southern Society of Orthodontists, Knoxville, Tenn., October 31-November 2.

STATE SOCIETIES

District of Columbia, at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June, inclusive.

November

Florida, at Hollywood (3-5).

December

Ohio, at Cleveland (5-7).

February

Minnesota at Minneapolis (7-9).

April

Michigan, at Grand Rapids (10-12).

STATE BOARDS OF DENTAL EXAMINERS

California, at San Francisco, December 12. Board of Dental Examiners, California State Bldg., Los Angeles.

Connecticut, at Hartford, November 16-19. Almond J. Cutting, Recorder, Southington.

Indiana, at Indianapolis, November 14. J. M. Hale, Secretary, Mt. Vernon.

Massachusetts, at Boston, November 14-16. W. Henry Grant, Secretary, State House, Boston.

New Jersey, at Trenton, December 5-10. John C. Forsyth, Secretary, 148 N. State St., Trenton.

Rhode Island, at Providence, December 6-8. Albert L. Midgley, Secretary, 1108 Union Trust Bldg., Providence.

Wisconsin, at Milwaukee, December 12-17. S. F. Donovan, Secretary, Tomah.

NORTHERN ILLINOIS DENTAL SOCIETY

The forty-fifth annual meeting of the Northern Illinois Dental Society will be held in Rockford, October 12-13, at Hotel Faust.

F. H. Spickerman, *Secretary,*
Rockford.

ST. LOUIS STUDY CLUB OF DENTISTRY

The St. Louis Study Club of Dentistry, organized for the purpose of providing postgraduate courses in dental subjects without charge to ethical members of the profession will open its fifteenth term, October 12, with sessions from 8 to 10 on Wednesday evenings. For further information, address

Frank C. Rodgers,
Missouri Theater Bldg.

MICHIGAN STATE DENTAL SOCIETY

The seventy-seventh annual meeting of the Michigan State Dental Society will be held in the Civic Auditorium, Grand Rapids, April 10-12.

William R. Davis, *Secretary,*
Michigan Department of Health,
Lansing

AMERICAN SOCIETY OF ORTHODONTISTS

The thirty-second annual meeting of the American Society of Orthodontists will be held in Oklahoma City, Okla., April 19-21. An invitation is extended to all ethical dentists to attend.

Claude R. Wood, *Secretary,*
Medical Arts Bldg.,
Knoxville, Tenn.

MINNESOTA STATE DENTAL ASSOCIATION

The Golden Jubilee Meeting of the Minnesota State Dental Association will be held in the Municipal Auditorium, Minneapolis, February 7-9.

L. M. Cruttenden, *Secretary,*
435 Hamm Bldg.,
St. Paul

MOUNT SINAI HOSPITAL LECTURE COURSE IN DENTAL MEDICINE

A second course of lectures in dental medicine is announced for the season 1932-1933, under the auspices of the dental department of Mount Sinai Hospital, New York City. All practitioners of medicine and dentistry are invited to attend.

Ralph H. Brodsky, *Secretary.*

CONNECTICUT DENTAL COMMISSION

The Connecticut Dental Commission will meet in Hartford, November 16-19, for the examination of applicants for license to practice dentistry and dental hygiene, and to transact other business proper to come before it. Applications should be in the hands of the recorder at least ten days before the meeting.

For application blanks and further information, apply to

ALMOND J. CUTTING, *Recorder,*
Southington

EASTERN ASSOCIATION OF GRADUATES OF THE ANGLE SCHOOL OF ORTHODONTIA

A regular meeting of the Eastern Association of Graduates of the Angle School of Orthodontia will be held at the Vanderbilt Hotel, New York City, November 14.

FREDERIC T. MURLESS, JR., *Secretary,*
43 Farmington Ave.,
Hartford, Conn.

BOARD OF DENTAL EXAMINERS OF THE STATE OF CALIFORNIA

The Board of Dental Examiners of the State of California will conduct an examination in San Francisco, beginning December 12. Credentials of all applicants must be in the office of the board at least twenty days prior to the above-mentioned date. For particulars, address

BOARD OF DENTAL EXAMINERS,
906-K California State Bldg.,
Los Angeles

REPORTS ON DENTAL CLINICS

The undersigned in making a study of the history of school dental clinics in the United States discovered that many clinics which functioned with considerable success did not render reports of their work to the dental journals. It is hoped that there are readers of this journal who know of the existence of dental clinics not hitherto reported. The undersigned would appreciate any information that would help in compiling a complete history of school clinics so that due recognition could be given the pioneers of this work.

J. M. WISAN,
1143 E. Jersey St.,
Elizabeth, N. J.

STATE OF RHODE ISLAND BOARD OF REGISTRATION IN DENTISTRY

A meeting of the Rhode Island Board of Registration in Dentistry for the examination of applications for license to practice dentistry and dental hygiene will be held at the State House, Providence, December 6-8, beginning each day at 9 o'clock. Candidates shall present to the secretary of this board, at least one week before the examinations, an application with fee and photograph. For application and further information, address

ALBERT L. MIDGLEY, *Secretary,*
1108 Union Trust Bldg.,
Providence

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1932-1933

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